THE RECEPTION IN RUSSIA OF DARWINIAN DOCTRINES CONCERNING EVOLUTION

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ABSTRACT

There are two important reasons for studying the reception of Darwinian concepts in Russia in the 19th century. First, very little is generally known in England about Russian biology and geology of that century and the period is especially interesting since it precedes that of modern Soviet science. Second, the differences and similarities of the reception of Darwinism in Russia with its reception elsewhere throw light on the general progress of acceptance and rejection of a scientific theory.

Darwin's theory of evolution affected man's whole conception of himself. Since it was a philosophy as well as a scientific theory the quality of its reception in Russia as in other countries was to a certain extent dependent on the cultural mores of that country as well as on the force of scientific argument.

In order to understand the reception of Darwinian concepts in Russia in its totality it was necessary to deal with the background in some detail. An outline of the cultural, social and political traditions in Russia

in the 19th century provides a background against which the reception of Darwinian concepts can be seen in its perspective and in its relation with the various intellectual discussions and cultural movements taking place during that time. A detailed description of the organisation of science and of the actual content of the sciences of biology and geology in the first half of the 19th century provides the necessary historical background to the state of science in Russia at the time of the dissemination of Darwin's book the Origin of Species, a background especially essential for the English reader. The actual steps by which Darwin's ideas were disseminated and the reaction from the reading public throughout the second half of the 19th century forms a skeleton in which the impact of the theory of evolution and of Darwinian concepts on Russian biology and geology and on its social and cultural ideas and of their impact in turn on the interpretation and emphases given to the theory and its concepts in Russia.

PREFACE.

Most of the sources for this thesis have been obtained in the British Museum Library or through its services and I would like to express my thanks to the staff at this point. Although I have been unable to see all of the sources in their original editions, I have generally found that the most important references were available to me in collected works or later reprints. In some cases I have sent to Moscow for those sources, such as Timiriazev's first comments on Darwin, that it was important for me to see in the absolutely original forms. I have tried to work from first hand 19th century sources using more modern works only for background and bibliographical references and I have found that generally sufficient material was available to me in this country using this method.

Since Russian scientists and other personalities are little known in Britain, I have included at the back an alphabetical list with short biographical data of the chief Russian personalities mentioned in this thesis. Separate notes will only be given for non-Russian or for Russians only mentioned once or twice in the text. In transliterating from Russian into English I have generally followed the method used by Alexander Vucinich in his Science in Russian Culture. However, for certain well known personalities I have kept the popular spelling where this differed from the previous method, for example Chernyshevsky instead of Chernishevskii and Belinsky instead of Belinskii. Within the text of the thesis I have translated the names of Russian reviews into their equivalent meaning in English so that it would read more easily. The original Russian name can easily be found by checking against the notes.

The appendices are aimed to give further background material to the thesis. In tracing correspondence between Darwin and Russian scientists, I was unfortunately only able to find the two letters presented in Appendix II. There must have been more letters than these but, if they do still exist, they have not yet been published as far as I know. The translation of an extract from Timiriazev's description of his visit to Darwin at Down is both interesting for its description of Darwin and for its picture of Timiriazev's relations with Darwin, Darwinism, and English science. The translation of an extract from Mechnikov's essay on Darwinism was chosen to give some idea of the quality of scientific discussion around this question in Russia and also of Mechnikov's own method of argument and analysis.

I should like to thank here my supervisor Professor A.R. Hall and his wife Dr. Marie Boas Hall for all their helpful suggestions and continuous stimulation and support. Many many thanks also to my mother for the tremendous job she has done in typing the whole of this thesis.

CONTENTS

CHAPTER I

The Political, Social and Cultural Traditions of 19th Century Russia.

The theory of the evolution of the species was not a theory purely confined to the realm of scientific thought and ideas. It was a theory which had an impact on the way in which man regarded himself in relation to the rest of the universe; and as such it was dependent for its acceptance not only on scientific proof but on an intellectual climate sympathetic to the basic philosophical ideas that it posed, ideas such as historical development, progress and change.

Before studying in detail the scientific background for the reception of Darwinian concepts in Russia it is important to obtain a general picture of the cultural climate of that country both before and after the date of the publication of the Origin of Species - a picture of interweaving traditions and developments of ideas - in order to be able to place the reception of Darwin's theory of evolution in the wider context of its implication for man, not only for science.

The intellectual climate in Russia at this time cannot be understood without reference to the political background of the country since the policies of the government had a direct effect on the intellectual life.

19th century Russia was basically a feudal country. Paradoxically it was Peter the Great who had finally legalised the institution of serfdom at the beginning of the 18th century, thereby creating a social system where each estate had its own duties:- the nobility had to provide officers for the army and the state; the peasants had to work the nobles' land, and they belonged body and soul to the nobles. At the same time Peter had forcibly flung open Russia's 'window on the west', thus accelerating her cultural and political contact with western European civilization. The paradox lay in the underlying contradiction of these two processes and it was not slow to reveal itself. By the end of the 18th century serfdom was proving to be an extremely uneconomic system for a country attempting to attain the level of society of west European countries. The nobility, who before had mainly lived off their lands, were now moving to the towns and demanding luxury goods that had to be imported and paid for by surplus produced by the serfs, but it was difficult to produce sufficient surplus under a forced labour system. In addition to its economic drawbacks serfdom posed an ethical problem as well. The ideas coming to

Russia from France, Germany and England questioned the morality of serfdom as a social institution. Throughout the first half of the nineteenth century all layers of Russian society were concerned with the problem of serfdom from one aspect or another. Although the serfs were eventually emancipated in 1861, their basic situation altered little and the feudal structure remained with its accompanying political and social problems concerning the future of Russia.

In the 18th and 19th centuries the Russian autocracy was faced with an insoluble problem - how to retain its absolute power and at the same time how to maintain Russia as a great power in Europe. It was a question of preserving the political structure of the state, an autocracy resting on the church, army and bureaucracy, while at the same time modernising the state economically so that it could compete with the developing industrial countries of western Europe. In this situation all new ideas were two-edged weapons. The importance and potential of science, in the sense of rational knowledge,(1) were realised by the Russian government, but certain philosophical ideas contained within it, such as an historicist attitude stressing the temporary and developing nature of society, threatened the existence of the autocracy. The fortunes of science and of the educational system were closely linked with the prevailing attitude of the government which never allowed either to achieve complete autonomy. Vigilance over the content of the teaching in the universities and censorships of published literature increased or decreased as the autocracy swung between policies of reaction and reform. And the government policies themselves resulted from events at home and abroad.

Catherine the Great (1762-96) started her reign in the spirit of reform: she corresponded with Voltaire, ordered Buffon's Natural History to be translated into Russian and generally imported French culture and ideas into the Russian Court. When, however, she saw these ideas result in revolution in France and was at the same time threatened by peasant rebellion at home, she became very wary of new philosophies advocating change and turned her back on her previous reforming ideals. This pattern of reform giving way to reaction was repeated throughout the 19th century. The beginning of the reign of Alexander I, 1803-1812, was a period of enlightenment and reform contrasting very favourably with the latter years of Catherine II's reign and the very reactionary period of Peter III's rule (1796-1803). However, after the defeat of Napoleon by the Russian armies, Alexander's policies became more and more imbued with mysticism and the ideas of the Holy Alliance. The peasant soldiers, who had fought on the understanding that they would be free men after the war, were soon disillusioned when the system of serfdom continued as before. A number of officers, fired by the ideals of the French revolution and the need for political and social change after their direct contact with France and French ideas formed secret societies with various aims of government reform, ranging from republicanism to a constitutional monarchy. Their activity culminated in the Decembrist uprising of 1825, an unsuccessful attempt to overthrow the Tsar. The following 30 years, from the Decembrist uprising until the end of the Crimean war, the years of Nicholas I's reign, were characterised by an increasing reaction from the side of the government and increased through sporadic rebellions from the side of the peasants. The reactionary policies of the state were not only a result of these peasant rebellions; they also resulted from the fear the autocracy had of the revolutions that occurred in western Europe in 1830 and 1848. It feared that such attempts for social and political change would spread to Russia and so an effort was made to seal off Russia from western Europe during this period. In 1855 Nicholas died and a year later Russia ignominiously lost the Crimean war. It was obvious that the policy of extreme nationalism had failed and that Russia had to modernise if she was to retain her position as a great power in Europe. The new Tzar, Alexander II, like many of his predecessors, started his reign as a reformer and he did manage to accomplish a certain amount. Faced with the choice of emancipation of the serfs from above or the certainty of a future explosion from below, he granted the serfs their emancipation in 1861. It was a half-hearted measure, however, full of compromise, and it left the peasants little better off than they had been before:- now tied to their masters by debt if not by law. In the early 1860s Alexander II also introduced certain reforms in the education and judicial systems and in local government. He was still, nevertheless, faced with an insoluble problem since the modernisation of Russia was incompatible with retention of power by the autocracy. His reforms and the autocracy were heavily criticised by the intelligentsia, a new class[(2)] that arose in Russia during the nineteenth century. Members of its radical wing attempted to assassinate Alexander in 1865. That together with other student disturbances and the 1863 rising in Poland discouraged Alexander from any further reforms. The rest of his reign was marked by policies of cautious reaction and an ideology of extreme pan-slavism at the time of the Russo-Turkish war in the Balkans at the end of the 1870s. A radical wing of the intelligentsia finally succeeded in assassinating him in 1881. For the rest of the century the autocracy, pursuing primarily reactionary policies, tried to maintain its authority and power over a changing country.

For Russia was changing, both economically and socially. The emancipation of the serfs had released labour for industry and during the second half of the nineteenth century the number of factories and industries in Russia had doubled and their production increased many times.(3) This industrialisation was characterised by very large factories, many with thousands of workers, and by a large dependence on foreign and state capital. The Russian industrial entrepreneurs never grew into a strong social force. They were always subservient to the foreign bankers.

Among the peasantry three classes appeared:- the kulak or rich peasant who owned land and was able to hire labour, the middle peasant, and the poor peasant, who generally had to sell his labour to live. The nobility were still attempting to live off their estates but many of the smaller landholders were going bankrupt.(4)

But this industrialisation and the accompanying development of capitalism in Russia were obvious only at the end of the nineteenth century. Until then the question of change and of the future of Russia had appeared to be open. It was a question of vital importance for the Russians, one that touched their whole identity as a nation and it was one that had been potentially present since the founding of "Rus" in 988. Basically the question was one of Russia's attitude to the West (i.e. western Europe). Was Russia culturally part of western Europe or did the Slavonic races have a unique destiny of their own?

This debate over Russia's identity in Europe had manifested itself in the seventeenth century in a conflict between traditional and foreign ideas. Throughout the century Moscow had to rely more and more on skill and proficiency from outside Russia to win her wars. A number of foreigners, doctors, ship builders etc., settled in Russia at this time. But a large section of the population distrusted these foreign skills and clung to their faith and the sacred past. The debate continued throughout the 18th and 19th centuries exacerbated by Peter the Great's forcing Russia's 'window on the west' wide open at the beginning of the 18th century, an action that irreversably opened Russia to the entry of western skills. The debate between the Slavophils and Westerners (as they were called in the 19th century) now centred on the historical destiny of Russia; it reached its peak during the 1830s.

Slavophilism was basically an extremely romantic ideology of nationalism. The Slavophils maintained that the Russian Orthodox church was the only true religion, that the Russian 'people'*were the only true Christians, their basic characteristic being their humility. Slavophilism was opposed to the influence of western Europe; it saw Russia's development as something unique based on the unique cultural-historical tradition of the Slav races. The Slavophils were searching for a national identity and they feared that Russia would be completely swamped by western influence and ideas. They regarded Peter the Great as an arch-enemy of Russia and felt that the autocracy descended from him represented an imposed German bureaucracy. The Slavophils idealised Russia's past and the uniqueness of the Slav soul and saw these as the basis for a unique and glorious Russian future.

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*The 'people' used in this context denoted the peasantry whom the Slavophils felt had not been corroded by western influences.

The Westerners, on the other hand, did not see anything unique in the Russian or Slav character. They felt that Russia was part of Europe and that laws of history and knowledge were universally true and applicable to both Russia and countries of western Europe. Thus, the Westerners looked to Europe to increase their knowledge and understanding in scientific, historical, political and other fields; unlike the Slavophils, they regarded the policies introduced by Peter the Great as extremely necessary and valuable for Russia's development. They were not, however, pure imitators of the west; they did not want Russia to follow slavishly the path of western Europe that seemed to lead to cataclysmic revolutions and extreme poverty and misery in the rapidly growing industrial towns. They did feel that Russia could industrialise on a different social basis - on a co-operative basis like the organisation of the peasants into communes. In fact both the Westerners and Slavophils came together on this point, and in their emphasis on the positive qualities of Russian peasant life and traditions.

This Slavophil-Westerner debate on the future and identity of Russia was carried on outside government circles and in fact outside any of the five established estates of

Russian society. These estates were the peasantry, gentry, clergy, merchants and soldiers - carefully graded classes, each with their own privileges and duties.

The autocracy gave no clear direction to the development of Russia. It walked the tight-rope trying to retain its absolute power and to develop Russia's economic and military powers at the same time. It swung from the total importation of foreign culture, usually either German or French, to an outright nationalism and a total rejection of all foreign ideas. The gentry(5) depended on the autocracy for their privileges and generally had little mind of their own. The clergy were a hereditary class, uneducated and despised. The peasantry formed the vast mass of the population. They rebelled continuously and spontaneously, but never with any clear idea of an alternative political system. Right up to the end of the 19th century they looked on the Tsar as their saviour, feeling that the hardships they suffered were not a result of his policies but of the mismanagement of his officials. The army also had little independence of mind - the officers were recruited from the nobility and the soldiers from the peasantry and minority nations in the Russian Empire. The fifth estate, the merchants, did not contribute directly to the intellectual life of the nation either. In western

Europe the merchant class together with the gentry had pioneered the new ideas of the Renaissance; they had sponsored and adopted the rational outlook. In Russia, however, many native merchants turned their backs on the Russian state when it began to open its doors to western Europe and adopt new ideas from there. These merchants belonged to a religious group called the "Old Believers" who, like Calvinists in the West, moved to the unpopulated regions of Russia in an attempt to escape the central control of the state. There they established communities based on their religion and on hard work. The ideal social order, according to their religious beliefs, was an organic religious civilisation of Great Russian Christians united by traditional forms of ritual worship and communal activity.(6) This virtual withdrawal of many of the merchant class from the political and intellectual life of Russia in the capital cities meant that their ideas and qualities never became fully integrated into the national culture; neither were they able to play a leading political role or form the basis of a strong industrial bourgeoisie as the merchants in western Europe had done.

During the 18th century what discontented intellectuals there were came from the ranks of the gentry. In the

19th century the rigid social structure containing these five estates began to loosen. This was a result of the slowly changing economic relations and of the development of education.[7] Consequently a new class emerged called the raznochintsy whose members might come from any of the five estates. The raznochintsy was the source of the intelligentsia of the 19th century - the journalists, writers, polemicists, artists, academicians, musicians, scientists, professors, etc.[8]

The intelligentsia came from more varied backgrounds than the members of the gentry class alone, but very few of them came from the peasantry or had a realistic understanding of peasant life and ideas - the life and ideas of the bulk of the Russian population.

The reforms and innovations of Peter the Great and other Tsars had introduced a secular culture to the gentry and educated classes of St. Petersburg and Moscow. However the old traditionalist and religious culture still continued to dominate most of the countryside. There was a split between the popular and elite culture. The intelligentsia, or its more radical wing, was alienated from both cultures, from the peasantry through education and from the nobility because of its social and sometimes revolutionary aspirations.

As mentioned earlier, Russian society of the 19th century was preoccupied with the question of Russia's identity and future and the group within which this discussion raged most fiercely was the intelligentsia, springing from the new class of raznochintsy. Between the 1840s and 1880s their vision was of a social transformation of Russia to a new form of human society where men could live simply and communicate spontaneously 'without any politics'.(9) This period of rejection of politics lies between the failure of the Decembrist uprising in 1825 and the rise of Russian marxism in the 1880s. It was a period of tremendous vitality in the field of culture and ideas.

The Slavophils were at the height of their influence in the 1830s and 1840s. They remembered the defeat of Napoleon by Russia as a red letter day in Russian history, the defeat of atheism and revolution by autocracy and Christianity, the true Russian principles. These ideas were further developed by the historian Karamzin(10) in his 12 volume survey of Russian history up to 1600. Karamzin gave Russia a glorious past and he gave articulation to the fundamental doctrine that Russia was somehow uniquely different from the West.

The split between the Slavophils and Westerners came in 1836. The Westerners were of a younger generation that did not remember the Napoleonic campaign or the early hopes of reform from Alexander's reign. They were influenced by Hegel and inspired by the thought that history proceeds through contradictions. 'All that is rational is real' became their algebra of revolution.

One of the leading Westerners was Herzen, the son of an impoverished nobleman, who had to seek exile in the West in 1847 because of his political views. He expressed most of the important themes that dominated the discussions of the 19th century over Russia's identity. As a Westerner, Herzen believed that the Russian state was subject to the same laws of development as the states of western Europe. His confidence in western progress was shaken, however, by the 1848 revolution which he witnessed in France. From that year on he believed that it was possible and necessary for Russia to progress straight from her present feudal state to a form of agrarian socialism. This was less a rejection of western culture and scholarship than it was a rejection of the contemporary form of western society. Herzen was influenced by Hegel's belief that only "the rational is real"; this became a formula of revolution for the radical Russian intelligentsia, who called for the destruction of "God and the State". Herzen believed in the importance of scientific knowledge but he always stressed that science could not be separated from philosophy, that experiment could not be separated from speculation. He felt that serfdom could be abolished and a new and better Russian society created on rational principles.

The ideas of both the Westerners and Slavophils threatened the autocracy with loss of absolute power, though their actual action was limited to discussions in small circles or kruzhki and to heavily disguised literary writing. After the 1848 revolutions the autocracy reacted viciously. The activities of journals were limited,[(11)] members of the kruzhki were sentenced to death or hard labour in Siberia,[(12)] the university lecturers were watched[(13)] and the word 'progress' officially banned.[(14)]

This period of reaction closed with the death of Nicolas I in 1855 and with the end of the Crimean war in 1856. It was followed by a national awakening in all spheres of life, - political reforms from the autocracy, a flowering of the arts and sciences, renewed and vigorous intellectual discussion. Timiriazev described it as "a national springtime, which reached every part of the country, awakening it from the intellectual numbness which had kept it in chains for over a quarter of a century."(15)

Herzen, still in exile, was replaced as leader of the radical intelligentsia by Chernyshevsky, Dobrolyubov and Pisarev. Herzen had not essentially been an extremist; he had believed in a revolution of the Russian social system but he had also believed that thie could be achieved through reason rather than violence. He congratulated the new Tsar Alexander II on the emancipation of the serfs. He was now, however, living in London and after this period was left behind by the pace of changing ideas in Russia. Chernyshevsky, Dobrolyubov and Pisarev understood that reforms introduced by the autocracy could not radically alter the social situation. They developed an extremism of ideas if not of actions, and they adopted a materialist philosophy based on the twin ideals of freedom of the individual and negation.

Freedom of the individual had long been an ideal of the Russian intelligentsia. Belinsky, a famous publicist of the 1840s, had eventually rejected Hegel's glorification of the state in favour of the individual. ". . . even if I should succeed in lifting myself to the highest rung on the ladder of development I should demand an accounting for all the victims of circumstance in life and history. . .(16)

In the 1860s, with the emancipation of the serfs which gave legal freedom to the vast majority of the Russian people, the intellectual ideal of the freedom of the individual seemed to be within grasp - the members of the intelligentsia called upon the individual to free himself from all manifestations of moral despotism. Chernyshevsky and Pisarev both thought egoism to be man's most important quality. Chernyshevsky rejected Darwin's theory of the struggle for survival on the basis that progress could not be achieved at the expense of individual destruction. Pisarev is famous for his attempt to annihilate aesthetics. For him art was only valuable to the extent that it was useful. In fact the important thing in life was to do what was useful and in the prevailing circumstances, Pisarev believed that was to destroy as much as possible. Side by side with this negation of present values, developed a strong belief in the potential and power of the natural sciences for the future of Russia. Many Russians believed at the time of the emancipation of the serfs that this was the beginning of the end, that the autocratic, paternal system of government must soon finish, and that Russia was about to be reorganised according to the most advanced principles of political and social science, i.e. of reason.[17] There was a tremendous faith in the latest results of science but a real understanding of scientific principles was quite rare. Darwin, Spencer, Lyell, Buckle, G.H.Lewes, Comte, J.S.Mill, Moleschott,[18] Buchner[19] and others were widely read and very popular. Pisarev preached the organisation of society by a technocratic-scientific elite and chided the great satirist Saltykov-Shchedrin[20] for writing fables when he would have been of more use popularising the natural sciences.[21] Chernyshevsky wrote in 1860 in an essay "The anthropological principle in Man" that "the observations of physiologists, zoologists and doctors abolish any idea of dualism in man".[22] He believed that once the peasants' faith in the Tsar had been demolished by reason (i.e. the concepts of science) the autocracy could be overthrown and society reorganized along rational lines.

The belief of the Russian radical materialists in the natural sciences gave the latter a slightly revolutionary character. In fact many of the student scientists of the 1860s were imbued with the ideals of a better society.

They carried on their research in the belief that achievements in science could help the lot of mankind. They did not, on the whole, involve themselves directly with any radical or political activity.

On the other hand the leaders of the intelligentsia who professed their belief in science as a weapon for the rational reorganisation of society did not, generally, have any training in or real understanding of scientific principles. "The nihilists were not men of science. They were men of dogmatic faith."(23) There was little tradition of independent scientific criticism among them. One writer had this to say:-

> " - Under European influence, Russians could be induced to negate myth, to negate theology but they could not be induced to criticize myth and theology. Russian thought is negative, but not critical; Russian philosophy is negation without criticism.
>
> "This explains why Russian negation remains believing negation. The educated Russian abandons the faith of his childhood, but promptly accepts another faith - he believes in Feuerbach, in Vogt, in Darwin, in materialism and atheism".(24)

Another writer found:-

> ". . . the methodical doubt of Descartes suits the nihilists, and indeed the Russian mind in

> general, but little. The typical Russian cannot go on doubting for very long; his inclination is to make a dogma for himself quickly, and to surrender himself to it wholeheartedly and entirely . . .(25

The materialists of the 1860s accepted the natural sciences as their Gods. They only acknowledged what could be measured, weighed and counted; only this was fact; all else was word and illusion. They hoped to achieve progress through the application of scientific principles to society, but their conception of progress in society was based on moral ideals rather than day-to-day facts. Chernyshevsky's rejection of Darwin's concept of the struggle for survival was the result of moral objections and not because of any empirical or scientific proof.

Towards the end of the 1860s the emphasis on science and negation gave way to an emphasis on the historical inevitability of progress. The metaphysical and revolutionary negative ideas of the early 1860s gave way to the more practical and positive ideals of service to humanity. This new trend in Russian thought came to be called populism and the young people who dedicated their lives to the Russian people were called populists or narodniks.(26)

The ideas of the populists were not entirely new but a development from earlier intellectual trends. They believed that it was possible for Russia to by-pass capitalism and instead develop a type of agrarian socialism based on the principles of profit sharing and communal endeavour, at that time still present in the peasant commune or obshchina.* Populist socialism involved a reconstitution of society on the model of the obshchina together with a creative development of this social form to guarantee the full development of the human personality. The populists felt that socialism could be achieved through the force of moral ideas, unlike the Marxist definition of socialism as a stage of society created by economic forces rather than human wishes. Resulting from this concept of "subjective socialism" was their belief that the transformation of society could be achieved by dedicated men of ideals. In 1874 they put their theory into practice. That

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*Obshchina is the Russian word for commune. At this time the bulk of the peasantry were still living in village communes where the land was shared out either according to the number of persons in each family or according to the number of workers. This idea was taken up by the students who tried to form communes in the towns - it was depicted by Chernyshevsky in his novel '<u>What is to be Done?</u>' where the heroine formed a sewing cooperative.

That summer thousands of young people, mainly students, went into the countryside to live with the peasants, to learn from the popular experience and to try to establish the bond of sympathy that they believed should exist between them. The result was disastrous. Many peasants turned the narodniki over to the police, and large numbers of the young idealists were arrested.[27] As a result such methods were generally abandoned. The populists split into a propagandist wing which stuck to journalism and a terrorist wing which tried to achieve change through assassination. They succeeded in killing Alexander II in 1881, but they got little response from the peasantry.

A faith in the popular experience, in the social structure of the peasant commune, was not solely confined to the populist movement. This concept can be traced in the ideas of the Slavophils, who thought of the idealised Russian state of the past as one vast commune, and who valued the quality of humility of the peasant as a basic characteristic of the Slav soul and one distinguishing the humble Slavs from the aggressive character of western Europe. It was also taken up by Herzen and other Westerners who were disillusioned by the failure of the 1848 revolutions in western Europe and turned to the Russian peasantry feeling they contained more revolutionary potential.

The belief in the peasantry in the 1860s covered a wide range of the political spectrum. The populists, as we have already seen, viewed the overthrow of the autocracy as the prerequisite for building a new socialist society based on the peasant commune. In a less political way the national flowering of the arts in this period was influenced by some of the ideas of the populists. Musorgsky, the composer, lived in a typical student commune of the 1860s, and tried to depict the people, their rhythms and speech in his music.(28) A group of artists, the "peredvizhniky", broke away from the official Academy of Art because the subjects it set were classical and far removed from the popular life. In literature writers and poets sought a solution to the hypocrisy and inhumanity of their lives in the values of the peasantry - for instance Tolstoy's idealisation of the peasant, Karataev, in '<u>War and Peace</u>', Dostoevsky's stress on Mother Russia and his philosophy of redemption through suffering. Both Tolstoy and Dostoevsky were far removed intellectually from the populists with their beliefs in revolution, realism and the scientific ordering of society. In 1864 Dostoevsky wrote '<u>Letters from the Underworld</u>' in which he refused to bow to the dictates of reason and science since these, he felt, could never solve the moral and spiritual problems of man. He also firmly supported the autocracy. Tolstoy felt too that the promises of science were illusory. He looked on science as just another occupation and deplored the tendency of youth to believe in science as a progressive force, as something that could improve human relations in society. Chekhov makes the same point.

The ideas of Tolstoy and Dostoevsky and other opponents[29] of materialism flourished in the late 1870s and 1880s, a period of political reaction.* It is interesting to note that these idealist thinkers were generally opposed to the official religion, Orthodoxy, as well as to the materialism of the revolutionaries. They shared with the materialists a dissatisfaction with the present way of life in Russia and therefore had to reject the Orthodox Church as it was an integral part of the autocratic set up. But unlike the materialists, they turned to faith or idealism as a means of achieving progress, instead of to science and revolution. Within this debate between idealism and materialism the Orthodox Church took little part. This was a result of its historical traditions and religious characteristics.

*The reaction was part of the development of extreme pan-slavism as a result of the Russo-Turkish war in the Balkans in the 1870s. The assassination of Tsar Alexander II in 1881 led to further reaction.

In both Russia and Europe the term Byzantinism has been used to characterise the Russian church and Russian ecclesiastical religion. The word implies excessive formalism, undue clinging to inherited forms and doctrines, satisfaction with externals such as ritual, liturgy, veneration for icons and relics, passive demeanour in religious matters, coupled with extravagant mysticism, and the amalgamation of the church with the state and with nationalism.(30)

The last of these characteristics resulted from the history of the church. Christianity came to Russia from Constantinople in the tenth century. When Constantinople fell in 1453 the Russian church became increasingly independent and aware of its own national identity. The Metropolitan of Moscow became the Patriarch of Moscow and the head of the Russian Orthodox church. With the appearance of a national church came a growing conflict between the church and the state. This conflict was decisively settled by Peter the Great in favour of the state. When the Patriarch Adrian died in 1700, Peter deliberately kept the patriarchate vacant. In 1721 he issued a decree which effectively turned the church into a department of state. The ultimate governing body of the church was to be the Holy Synod; its members were to be appointed by the Tsar; they would all be ecclesiastics except for the Chief Procurator, whose other name could have been, I suppose, the Minister of Religious Affairs.

Trotsky described the position of the church in relation to the state in the following way:-

> "The church never rose in Russia to that commanding height which it attained in the Catholic west . . . The bishops and metropolitans enjoyed authority merely as deputies of the temporal power . . . 200,000 priests and monks were in all essentials a part of the bureaucracy, a sort of police of the gospel."(31)

Sir Donald Mackenzie Wallace, a frequent traveller to Russia in the second half of the nineteenth century and a well-known commentator on Russian affairs, observed that "the Tsar exercises a much greater influence in ecclesiastical affairs than the Queen and parliament."(32)

The close association between church and state meant an identification of orthodoxy with the policies of the Tsar. Uvarov, the Minister of Education, defined in 1836 the three chief principles necessary as the basis of the Russian educational system if the country were not to follow the revolutionary paths of western Europe, as "autocracy, orthodoxy and nationality".(33) This characteristic of Byzantinism, the amalgamation of the church with the state and with nationalism, resulted in its lack of independence, intelligence and integrity.

Another characteristic of the Orthodox church was its dependence on revelation rather than reason. Its precepts were blindly accepted because they derived from the God-man, Christ. There could be no progress, no development because God had revealed the highest truths through Christ. Men could add nothing and had to accept them unquestioningly. This meant that the Russian religion and Russian church were unprogressive on principle. Religious doctrine and religious practice had to remain exactly as they had been since they were established in the third century.

In the 17th century there was a deep split in the church over the question of textual and ritual reforms. The patriarch Nikon inaugurated the reforms and succeeded in getting them accepted by the church. However a large sect, the Old Believers, refused to accept these reforms and broke away from the church, as a result. They were not, however, able to formalise their position or right to hold to different beliefs and rituals although their numbers were not insignificant - perhaps as many as twenty millions at the time of the 1917 revolution. They were always liable to persecution from the government, thus further illustrating the close identity of the official church and the state. The significance of this split in the church with regard to Russian religious tradition lies in its concern with the question of the truest and most accurate rendering of the dogma and ritual of the early church fathers. In intellectual terms it was a formalistic discussion, not a question of bringing the church in line with contemporary knowledge.

In fact the church tended to ignore the new ideas of science and philosophy that came flooding into Russia from the 17th century onwards. In the 18th century it managed to exercise a certain censorship,* but the extent of its censorship was limited by the attitude of the autocracy to which it was bound. On the other hand the church made no attempt to adapt its dogma to the new

*Fear of the church kept papers on the Copernic~~i~~an system from appearing in Russian publications of the Academy of Sciences; church censorship delayed publication of Kant's cosmogenic theory and suppressed Buffon's Epochs of Nature (see Vucinich, pp. 87; 183) ideas and in the 19th century one commentator had this to say:-

> "Immobility and passive resistance to external influences have always been and still are, her [the Russian church's] fundamental principles of conduct. She prides herself on being above terrestial influences . . . To all that is said about the requirements of modern life and modern science she turns a deaf ear. Partly from the predominance which she gives to the ceremonial element, partly from the fact that her chief aim is to preserve unmodified the doctrine and ceremonial as determined by the early Ecumenical councils, and partly from the low state of general culture among the clergy, she has ever remained outside of the intellectual movements. The attempt of the Roman Catholic church to develop the traditional dogmas by definition and deduction, and the efforts of the Protestant Churches to reconcile their teaching with progressive science and the ever-varying intellectual currents of the time, are alike foreign to her nature. Hence she has produced no profound theological treatises conceived in a philosophical spirit of infidelity in its modern forms. Profoundly convinced that her position is impregnable, she has 'let the nations rave', and scarcely deigned to cast a glance at their intellectual religious struggles. In a word, she is 'in the world, but not of it'"[34]

One of the reasons for the church's lack of interest in intellectual movements outside its own door was the low intellectual level of the priests. The clergy were divided into two groups: the 'black' monks and the 'white' village priests. The monks were celibate and it was from their ranks that the higher posts - bishoprics and metropolitanates - were filled. They represented the extreme mysticism of Byzantinism. The monk was an ascetic close to God and despising the life of this world. If he was holy enough (i.e. far enough removed from the principles of the daily world) he was able to work miracles and revelations. The 'white' clergy were on a lower level than the 'black' monks and represented the low intellectual level and generally superstitious character of the orthodox religion. In literature the 'Pop' or village priest is a figure of fun, not someone who is to be respected as a teacher and guide in both matters of religion and of living. Belinsky wrote to Gogol:-

> " . . . Don't you know about whom the Russian people tell bawdy tales? They tell them about the priest, the priest's wife, the Priest's daughter and the priest's labourer. Whom do the Russian people call stupid over-healthy swindlers? The priests. There isn't a priest in the whole of Russia who isn't for the Russian people the

> representative of gluttony, meanness, obsequiousness, shamelessness . . ."(35)

The priest was often illiterate and it was only when he was conducting a service that the village population regarded him in anyway as better than themselves. The Russian looked upon his priest as a live 'good conductor' of divine grace, as a passive mediator. The 'white' clergy were an hereditary class; they were also a very poor class as the bulk of the church's riches were kept in the monasteries.

Thus the two groups of the clergy represented either mysticism or ignorance. When the autocracy began to sponsor the new scientific knowledge from the west, the precepts of Russian Orthodoxy became identified in the eyes of the nobility and intelligentsia with all that was barbaric and antiquated. They represented the traditions and way of life of pre-Petrine Russia. Russia became divided, as it seems, into two nations - the aristocratic and official society, which strove to achieve civilisation, polish and acceptance by adopting foreign traditions and culture (including atheism); and the peasantry and merchants who, unaffected and mostly unaware of the new knowledge and ideas, stuck to their religious beliefs and customs. The division of Russian society into two nations, one basically irreligious and one basically religious, was not so clear cut as this description appears to merit. Though few of the nobility and educated class were sincere believers in the orthodox religion, many adopted new beliefs with the zeal of religious converts.(36) The peasantry, on the other hand, appeared outwardly religious and many writers looked to the 'people' for a religious regeneration of the atheistic, materialistic and hypocritical society of the upper and educated classes.(37) Other writers and philosophers, however, opposed this view completely, finding the peasantry superstitious but totally lacking in the religious qualities of piety, veneration and fear of God.(38) In the wealth of speculation about the peasantry, the 'people' and the popular experience that went on in the 19th century, it is difficult to distinguish the wishful thinking, the search for an ideal, from the facts and reality. They probably all represent a facet of the truth.

The 19th century characteristics of the Russian Orthodox church - its lack of independence from and extreme servility to the ruling autocracy, its lack of interest and interference in ideas outside its own dogma, the

the low intellectual level of its clergy, and the firm rejection of its traditions and dogma by the nobility and educated classes - these characteristics prevented the Orthodox church from taking a significant part in the intellectual debates of the 19th century. Basically these debates and discussions were between two opposites: autocracy and revolution or reaction and progress. The Orthodox church was so closely identified with the autocracy that it was unable to produce a champion of any intellectual standing. It is interesting to note that even religious and idealist ideas, independent of the Orthodox church, were tarred with the same brush of reaction or support for the autocracy. The religious-idealist revival referred to before achieved its greatest influence in the last quarter of the century, a period of political reaction and extreme nationalism, when materialism and revolution were on the defensive.

Russia was a country of extremes - in its social stratification, in its ideas, in its emotions. There was no room for compromise, for a middle way. As one intellectual put it:-

> "How difficult is solitude! . . . When I speak against Darwin people think that I am for catastrophes, when against nihilism then they consider me a defender of the state and existing system; if I speak against the harmful influence

> of Europe, then they think that I am on the side of the censorship and every kind of obscurantism etc . . . The position in Russia is such that there is no path between the revolutionaries and the reactionaries; these two tendencies strangle everything."(39)

The Russian political traditions, their lack of assurance in their national identity - these were the basis for the extremism that was typical of Russian intellectual discussions. The 19th century was the background to a series of criss-crossing processes and situations. There were economic crises, the continuous swing of the autocracy between reaction and reform, the increasingly revolutionary character of the radical intellectuals as an answer to the frustrations of autocratic reaction. It was a period of national awakening and awareness. The search for an identity resulted in various contradictory trends: a turning to the west and a rejection of all western knowledge; a turning to radical realism and to spiritual idealism. The Orthodox church was impotent to contribute. The Russian intellectuals thrust to the depths for the answer.

Within this mêlée any one concept or theory tended not to be an issue in its own right but only part of the immense polemic over Russia's identity that waged continuously.

CHAPTER II

The Character of Higher Education and the Natural Sciences in Russia in the 19th Century.

In Russia creative scientific activity was indissolubly linked with the higher educational system, which in its turn was primarily dependent on government initiative and support. In fact there were practically no private scientists, of whom Darwin himself was a prime example, as were to be found in western European countries. These two factors - the link with higher education and dependence on the state - were of fundamental importance for the character and development of the natural sciences in Russia.

The Russian educational system which had been founded by Peter the Great at the beginning of the 18th century,* consisted of an hierarchy of institutions. On top there was the Academy of Sciences, below came the universities, medical, technological and other higher institutes, then there were the secondary schools and below them the primary schools. The secondary and primary school layers were not very well developed by the government

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*Peter I founded the state system of education. Schools had existed before, chiefly run by the church.

and only covered a small percentage of the total population.

Peter the Great conceived the idea of creating an Academy of Sciences on Russian soil to be an equal with any that existed in western Europe. He corresponded with Leibniz about the matter and, on the latter's inspiration, the Academy was modelled on the French Academie Royale des Sciences. Peter himself did not live to see his idea come true, dying in 1824, a year before the Russian Academy was opened.

The statutes of the Academy provided that the Academicians should engage in independent research in their respective disciplines, prepare extracts from foreign publications, pass judgement on inventions submitted for their approval, provide expert answers to inquiries from government departments and prepare Latin and Russian textbooks.(1) They were also supposed to carry out teaching duties and an attempt was made to form a university attached to the Academy. This, however, was not very successful mainly for two reasons. Firstly the majority of the Academicians were foreign, unable to teach in Russian, and secondly their academic level was at first far above that of educated Russian circles.

The failure of the teaching role of the Academy was offset by the opening of Moscow University in 1755, again on government initiative and backing. No more universities were opened until the beginning of the 19th century when five were founded in quick succession: Dorpat in 1802, Vilna in 1803, Kazan and Kharkov in 1805 and St. Petersburg in 1819.(2) Three more were opened during the rest of that century: Kiev in 1830 which replaced Vilna, closed down in that period as a result of the 1830 revolutions in western Europe; Novorossiisky at Odessa in 1865 and Tomsk in Siberia in 1888. The universities, unlike the Academy, were based on German models, but they never achieved the latter's automony. Other institutes of higher education developed parallel with the universities.(3) Connected with this expansion of higher education was the founding of a number of scientific societies and journals. These were usually begun and run by individuals without governmental direction but were often attached to university or similar institutional departments. All these bodies were important in defining the character and development of the natural sciences in Russia.

Higher Education and the Government.

Education itself represented to the government a two-edged weapon. It was necessary to develop and expand the educational system so as to provide the expanding Russian Empire with the qualified personnel to run the state apparatus and exploit its economic resources. On the other hand the increasing numbers of the intelligentsia and their contacts with Europe and European ideas challenged the very existence of the political framework of the society and threatened the Tsar with revolution and social change. Since education was primarily dependent on the government for support, it was constantly subject to vacillations of policy brought about by the political situation in Russia and abroad. The natural sciences found themselves in a similar situation, though they were never regarded with such suspicion as the social sciences. For one thing their relevance to society was not so direct or obvious, and secondly their useful application in the fields of industry and agriculture was a strong point in their favour.

The political situation in Russia in the 18th and 19th centuries, as has been outlined in the previous chapter, tended to alternating periods of reaction and reform.

Higher education and the natural sciences were affected by the political situation.

Towards the end of the 18th century, Catherine II had set up a commission to prepare plans for the reorganisation of education in the Russian Empire. Perhaps because of the political reaction resulting from the French Revolution and the Pugachev peasant rebellions at home, nothing was actually done until the beginning of Alexander I's reign. The renewed vigour and interest in education on the part of the government coincided with the atmosphere of reform widespread at that time. A Ministry of Education was set up in 1802, and new charters were promulgated for the Academy of Sciences in 1803 and for the universities and secondary schools in 1804.

The university and secondary school charter provided for an education system centralised under the Ministry. Russia was divided into six regions, which were controlled by six curators appointed by the government. In the absence of the curators, the university in that region assumed control. In fact the idea was to maintain very close liaison between the universities and the secondary schools, so that the latter would supply the universities with students, and the universities in turn would supply teachers to the schools. Each university was supposed to have a pedagogical institute attached to it. The universities themselves were modelled on the German system. They were autonomous with an elected rector, deans and inspector. The running of the universities was carried out by the elected body and the curator appointed by the government. Teaching courses, examinations, the election of professors etc., were approved by a council made up of the professors and their assistants.(4)

The Academy charter was similar in spirit to that provided for the universities, allowing for the wider participation of the Academicians in the administration of the Academy and in the conduct of their research. At the same time it brought the Academy under the jurisdiction of the Ministry of Education.(5)

The enlightened ideas contained in these charters did not correspond with the objective situation in Russia at that time. Moscow was the only university that had been in existence for some years and had built up a strong body of professors and traditions. All the other universities were recently founded and it was fairly easy for the principle of autonomy to be abused once the public mood had lost its reforming zeal and enlightened ideals.

This soon happened with the onset of the Napoleonic wars and ensuing mystical policies of the Holy Alliance. In Russia the year 1816 marked a tremendous cultural break in the official circles of society. There was a revulsion against the ideas of the enlightenment of the eighteenth century and against the results of the French Revolution. The previous atmosphere of reform and free thought had not had time to take firm root and there was a consequent falling back on religion, which in the case of Alexander took the form of an obscure mysticism. He felt that the Holy Alliance should not only recreate order in the international sphere, but should also be imbued in the hearts of the people. Education should be based on piety. In addition to the spirit of the Holly Alliance there was a fear of the potential political danger of the universities since in Germany students had taken part in the movement for a national constitution.[6]

Uvarov described the intellectual climate as chaotic:-

> " . . . the confusion of ideas has no limits. Some want harmless enlightenment i.e. a fire which won't burn; others (and they are in the majority) throw together in one heap Napoleon and Montesquieu, the French armies and French books . . . in a word it is such a chaos of shrieks, passions, parties . . . enraged one against the other, that it is unbearable to witness.(7)

In the universities and higher institutes this new atmosphere resulted in an emphasis on religious teaching, which now became compulsory for all students, a rejection of foreign ideas, the appointment of Russians wherever possible to teaching posts and the reading of lectures in Russian. The two universities to suffer most under this new regime were Kazan and St. Petersburg whose curators, Magnitsky and Runich, were firm supporters of the policy of the Holy Alliance. Their policies resulted in the demoralisation of the staff and students and the cessation of literary and scientific activity.* In other universities the effect was felt less strongly. In Kharkov two professors were dismissed and in Dorpat three professors had to leave the theology department because of their rationalist views.

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*In Kazan the entire curriculum was to be based on the Bible. Geology was outlawed as hostile to the Biblical teachings and mathematicians were told to point out that the hypotenuse of a right-angled triangle represented the mercy of God descending to man through Christ. See Billington, pp 290-2.

By 1827 the extreme policies of Magnitsky and Runich were losing their predominance and a less hysterical attitude prevailed. All the same there was a general disapproval in government circles of the principles of the 1804 charter. It provided for a university structure that was felt to be republican in spirit and entirely in contradiction with the organic nature of the Russian state, based as it was on the principle of monolithic power and the direct dependence of lower institutions on the higher ones.*

The need for a new charter was further confirmed by the 1830 revolutions in western Europe. The autocracy reacted violently to these, closing down Vilna university in 1830 and founding in its place a new university at Kiev as an "intellectual fortress close to the war" with the aim of "crushing the spirit of independent Polish nationality and of merging it with the general Russian spirit".(8) The problem facing the autocracy was to find the basis for a culture which would provide educated

*In fact the nobility had counteracted the effect of the 1804 charter by establishing aristocratic boarding schools, which were in effect schools within the universities, where their sons could receive a university training without having to mix with other classes.

personnel, but which would counteract the all-corroding influence which modern knowledge was having on societies in the west. The Minister of Education at this time expressed the dilemma in the following words:-

> "With the rapid deterioration of religious and civil institutions in Europe, and with the dissemination everywhere of destructive ideas, we must strengthen the fatherland on firm foundations. We must find the principles on which the country's prosperity is based, and the forces which make up the unique character of Russia and which are exclusive to her. We must collect together the sacred relics of her nationality and fasten our anchor of salvation to them. Happily Russia has retained a deep belief in saving principles, without which she cannot prosper, grow strong, live . . . . A Russian devoted to his fatherland would as much agree to the loss of one dogma of our <u>orthodoxy</u>, as he would to stealing the pearls from Monomahov's crown. The <u>autocracy</u> is the chief condition of the political existence of Russia. Together with these two national principles is a third, not less important, not less forceful: <u>nationality</u> . . . . These are the chief principles which we must include in the educational system."(9)

In other words education had to be based on the three very firm principles: Autocracy, Orthodoxy and Nationality - three principles which were in Uvarov's mind an integral part of Russian society and absolutely necessary if it was not to go the same way the European countries were going.

A new charter was introduced in 1835, revealing a governmental policy that had matured over some period. It imposed stricter government control over the universities. They were now to be under the direct control of the appointed curator. The rector and deans were still to be elected, but for a period of four years instead of one, so that their administrative character was strengthened. It was decided to concentrate on producing Russian professors, so as to stop the previous reliance on foreign scholars. The number of students from the lower classes was limited; the upper classes were to be encouraged to enter the civil service. A set of rules for student behaviour was drawn up. Changes in the content of teaching aimed at weakening the theoretical basis and emphasising the applied and dogmatic were introduced.(10)

The nationalist policy of the government affected the Academy as well, and in 1836 it, too, received a new charter. This was at a time when the Minister of

Education, S.S.Uvarov, was also the president of the Academy and the charter reflected his ideas:- a distrust of scientific theory, a healthy respect for applied science, a belief in the Academy as a repository of useful facts that could help the government solve practical problems, an eagerness to use the Academy as a showcase of Russia's contribution to modern scientific thought.(11) At the same time the government also tried to solve the problem of foreign domination which was still obviously present in the Academy, even in 1836. It decided that the Academy of Sciences should be joined to the Russian Academy, an institution founded in 1783, devoted to Russian language and literature, whose members were predominantly Russian. In 1841 the two bodies were merged and the joint membership had a majority of Russians.

The period immediately after the 1835 and 1836 charters was important for the steady development of higher education and the natural sciences, forming, as it were, the jumping-off ground for the tremendous development of the sciences that occurred during the following decade. The students of the 1840s formed the solid core of scientific workers responsible for the developments of the late 1850s.

Between these periods of steady progress and achievement, however, there was another of the periodic setbacks ever present in Russian history. The 1848 revolutions in the west were followed by 'seven dark years' in Russia, a period of reaction coinciding with the Crimean war which ended only with the death of Nicholas in 1855. A number of measures were taken at this time with regard to education. In 1849 the number of students in each university, not counting the medical faculties, was reduced to 300, and visits abroad were forbidden. The content of university teaching and the subjects of student dissertations were restricted to definite syllabuses. The teaching of state law was stopped and philosophy was moved to the theological department. In 1852 it was forbidden to engage foreign lecturers for vacant posts.(12) Students were subject to a strict set of rules. Some idea of the restrictions under which they had to live can be gleaned from the fact that there were 1,491 arrests and imprisonments of students at Kharkov university between 1848 and 1856 and the offences they had committed were as follows:-

370 - for not attending lectures
259 - for not attending university church
176 - for disregarding the rules
168 - for disobedience
138 - for absence without leave from the hostel

55 - for smoking
108 - for attending public meetings
119 - for impoliteness
51 - for disorderly behaviour
25 - for drunkeness[13]

A professor at Kazan adds to this list of misdeeds the following:- having long hair and whiskers, not wearing a tie, wearing an unbuttoned frockcoat at dinner, etc.[14] The punishment for breaking these archaic rules could be extremely harsh. Students were expelled, imprisoned and sent into the army.

The accession of Alexander II in 1855 and the ending of the Crimean war in the following year signalised a general spring after the dark years of reaction. Many of the measures restricting university life were lifted and the universities gradually returned to the normal conditions of the 1835 charter. In 1856 the compulsory lectures on military methods, introduced during the Crimean war, were stopped; the following year the teaching of European state law was renewed; the department of philosophy was re-established, the ten year experiment to teach logic and psychology together with theology having proved itself unsuccessful; the universities were again allowed to invite foreigners to their departments and to subscribe to foreign books and periodicals without the censor's approval.(15)

1855 may have signalled a spring after the dark years of reaction but it did not bring a solution to the contradiction between the political and educational aims of the autocracy any closer. The reforming mood of the early 1860s, manifested concretely in the emancipation of the serfs as well as other judicial and local government reforms, aroused expectations far higher than the autocracy was prepared to tolerate. Students were the chief agitators for more reform. Disturbances occurred at many universities and in 1861 St. Petersburg had to be closed down completely for a short while. A Commission that had been set up by Moscow university to investigate student disturbances had this to say:-

> "Russian society has given the student such an idea of his worth as is not to be found in any other country. In those places where education is disseminated among the people and has put down strong roots, the student fits into a natural place in social circles. In Russia the student becomes the representative of enlightenment, and at the present time every Russian feels deeply the need for education as the only way out of oppressive social evils. Moreover our custom, resulting from our own inaction, of entrusting all our obligations as much as possible to others means that the rising generation always considers itself the one chosen

> for action, at the same time as the generation reaching maturity begins to peacefully enjoy life. The young people are thus consciously fulfilling their high calling. The student in Russia is not a pupil but a teacher; society looks on him with a certain amount of pride and respect. For many, the student represents the future hope of Russia."(16)

In an attempt to deal with these excesses and also to bring the management of the universities into line with contemporary thinking, the government introduced yet another new charter in 1863. The public and government mood at this time was still one predominantly of reform and not reaction and the new charter, the terms of which had in fact been discussed in public, corresponded with this mood. In contrast to the 1835 charter it provided for the autonomy of the professorial body, which was to have control over the internal organisation of the university, the curricula of the faculties and the reorganisation of the latter.(17) It tried to control the student disturbances, not by increased discipline or direct government control, but by strengthening the influence of the university authorities over them. This meant that the students then came under the legal jurisdiction of the university and not the state.

Despite these measures the students continued to rebel: the political situation gradually worsened with the autocracy on one side clinging desperately to its absolute power and with the students and intellectuals on the other searching for new forms of social and political organisation.

1869 saw student disorders in St. Petersburg university, the Medical-Surgical Academy and the Technological Institute. Between 1873 and 1877 fifty per cent of all people taking part in anti-government propaganda were students of higher or secondary education.(18) The government was especially suspicious of the natural sciences:-

> "But what, it may be asked, has social reform to do with natural science? . . . Though very few of the students of the time had ever read the voluminous works of Auguste Comte, they were all more or less imbued with the spirit of the Positivist Philosophy, in which all the sciences are subsidiary to sociology, and social reorganisation is the ultimate object of scientific research. The imaginative Positivist can see with prophetic eye Humanity reorganised on strictly scientific principles . . . As soon as they [the Russian youth] had acquired a smattering of chemistry, physiology, and biology, they imagined themselves capable of reorganising human society from top to bottom . . ."(19)

In 1881 a student revolutionary group succeeded in assassinating the Tsar.

A new charter was introduced in 1884 and, as in 1835, it reverted back to the principle of direct government control of the universities. The elective principle was abolished, and with it the principle of autonomy. Lectures had to correspond to a previously approved syllabus and state exams were introduced to control the teaching. Only those students having a certificate of education from a gymnasium were allowed to entre, and their fees were raised. All student organisations were closed down and a close inspection of their lives was maintained.(20)

The autocracy might vacillate in its administrative attitude to higher education, trying to accommodate the two-edged weapon of knowledge, but objectively in the 19th century the educational system succeeded in establishing itself and putting down roots which were impossible to disrupt totally by simple administrative procedures or directives.

Russian Scientific Workers.

The Academy of Sciences, Moscow university and the other universities had all been founded on the initiative of the state, which provided the funds and objectively had complete control whatever the charters might say. There had been no coherent demand from any section of the population for this type of higher education or scientific research, both of which appeared to be alien elements imposed upon Russian society from outside.* Consequently there was a long period when the scientific institutions and higher educational system were putting down their roots in Russia and when it was impossible to man satisfactorally either professional or student bodies solely from the native Russian population.

The sixteen scholars who arrived in St. Petersburg in 1925 as the original members of the Academy were all foreign, 13 from Germany, 2 from Switzerland and one from France.(21) From the very beginning the Academy had a strong tradition of mathematics, of which Euler was the main representative, and by the end of the 18th century the mathematical tradition had taken firm root in Russian scholarship. The first half of the 19th century saw the work of a number of original and brilliant Russian mathematicians including Lobachevsky, Ostrovitianov and Chebyshev. However, it took somewhat longer for foreign predominance to be eliminated from other scientific fields

*They were in fact premature rather than alien elements. Peter I's reforms precipitated a process that had already begun.

in the Academy. Of the fifteen Academicians and Adjuncts elected in the fields of zoology, botany, anatomy and physiology, and geology between the 1803 and 1836 charters, twelve were foreign or of foreign extraction and only three were Russian.(22) In 1852 none of the fifteen regular and associate members of the Academy working in the fields of astronomy, physics, chemistry, botany, zoology, geology and physiology and anatomy were Russian by ethnic origin.(23) The year in which a Russian was elected to these fields is given in the following table:-

Chemistry	- 1855	botany	- 1865
astronomy	- 1862	physics	- 1875
anatomy & physiology	- 1862	geology	- 1886
		zoology	- 1890 (24)

The membership of the Academy did not however represent the true character of Russian science in the 19th century. For a number of reasons, including perhaps its close association with the autocracy and its long tradition of foreign scholarship, the Academy was never very involved in the promotion of Russian science and scientists and many Russians felt that it did not represent their interests. In the field of the natural sciences it is notable that the famous zoologist A.O.Kovalevsky was not elected till 1890, quite late in his life and work. The physiologist I.M.Sechenov was nominated as an adjunct in 1868. His nomination failed that year and again six years later. He was eventually elected an honorary member in 1904.[25] The biggest scandal concerning the non-election of suitable Russian scientists occurred in 1880 when Dimitri Mendeleev was nominated but not elected as an academician. Butlerov protested about this non-election in an article entitled "A Russian or Purely Imperial Academy in St. Petersburg".[26]

The universities provided a more accurate barometer of the situation in higher education and scientific scholarship. The difficulty of attracting men to the universities and other higher institutes was increased by the rigid class and rank system existing in Russia. It was difficult to move from one to another of the five classes - the peasantry, merchants, soldiers, clergy and nobility - and the status of the professional scholar was not provided for in any one of them. Of these classes the merchants had opted out of the new Russian society,[27] the nobility were generally indifferent to the aims of higher education and preferred to send their sons to a military establishment if anywhere, while the lower classes, the peasantry and clergy, were generally too poor and ill-prepared to be able to get into a university.

The rigid class stratification began to break down only in the 19th century when the new raznochintsy class appeared, itself the result of the slowly developing education, and it was from this class that the majority of professional scholars came. The lack of interest of the nobility and the fact that most members of the raznochintsy had no private means of support, meant that there were few 'gentlemen scientists' in Russia; scientists and scholars were dependent for their livelihood upon their professional academic jobs.

The manning of the universities and other higher institutes with Russians was a fairly slow process. The 1804 charter had organised the universities into four faculties - the philological faculty with seven departments, the physical-mathematical faculty with nine departments, the moral and political science faculty with seven departments and the medical faculty with six departments.(28) This made five universities each having a complement of twenty-nine departments, whereas before there had only been Moscow university with ten departments. Consequently a severe shortage of teachers resulted. In Moscow foreign professors had to be brought in to teach botany, chemistry, physics, mechanics, astronomy, history of philosophy and statistics.(29)

Kazan university was not fully opened until 1814, and the authorities had to hire foreign professors although they were unable to lecture to the students in Russian.(30) In Kharkov only three out of the four planned faculties were opened at first, and even by 1812-14 only two subjects in the natural sciences were being taught.(31)

Before the Napoleonic wars an effort had been made to remedy the shortage of professors by sending students abroad for training. In 1808 twelve students from the St. Petersburg pedagogical institute were sent on such a scheme, of whom seven later became professors at the St. Petersburg university. These training programmes, however, were brought to a halt by the Napoleonic wars and ensuing policies of the Holy Alliance and were only renewed after 1835. They then continued regularly up to 1848 when again they were halted by political events.

The shortage of staff persisted well into the second half of the 19th century. The 1835 charter had provided for 265 teaching posts, and all in all in 1863, on the eve of the new charter 72 of these were not filled, including a third of the professors's posts in Kiev university and a quarter in St. Petersburg. It was only

Moscow university that managed to have a fairly adequate quota of staff. The new charter itself exacerbated the position as 178 new posts were created[32] and at first only 200 of the 443 teaching positions were filled. To try and improve this situation a decree was issued in 1862 allowing the hiring of foreign staff, and between 1862 and 1865 eighty-four Russian students were sent abroad to prepare for professorships.[35] In addition, the salaries of professors were increased by the new charter.*

Although the staff situation was still difficult it does ~~not~~ appear that the higher educational system had firmly put down its roots by the middle of the 19th century, in the sense that there was by then a definite demand for higher education from the population itself.

The position with regard to the entry of students into the universities was now the reverse of what it had been fifty years before. At the beginning of the century the government had had difficulty finding enough students

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*An article in Russkii Vestnik (1860, vol. 30, pp. 107-17) described the position of professors and said that one of the main reasons for the shortage was the bad pay professors received.

to fill the universities. In 1808 the total number of students at the five Russian universities was 450,(34) and they had to be cajoled to enter. However, by 1860 there was a large discrepancy between the number of people wishing to enter university and the number actually admitted. In 1859 out of nine hundred students wishing to enter Moscow and St. Petersburg universities only two hundred had been accepted.(35) The reason for this reversed situation was the increased numbers of children receiving secondary education. The figures for the first half of the 19th century were:-

1808 - 5509	1847 - 20,000
1825 - 7509	1855 - 17,817

1863 - 29,524(36)

Despite the small drop after 1848, due to government policy, by 1863 the numbers had increased five fold since the beginning of the century. This expansion of secondary education provided a minimum core of pupils qualified to enter university, and it was the base upon which the continued growth of the higher educational system depended.

Scientific Institutions.

The quantitative expansion of higher education and its gradual naturalisation into Russian society and culture was a determining factor for a similar expansion and naturalisation of the natural sciences. The development of the sciences was also accompanied by the growth of distinctive organisations, such as the scientific society and scientific periodical, organisations which faced similar problems in their development as the institutions of higher education.

The first partly scientific society to be formed in Russia was the Free Economic Society founded in 1765. Its main aim was to improve the agriculture and economy of the country.(37) No more societies were formed until the beginning of Alexander I's reign with its encouraging policy towards education. Just as this period signalled a crop of new universities, it also signalled a crop of scientific societies, most of which were dependent on the universities for their personnel. The most successful of these was the Moscow Society of Naturalists founded in 1805. Its aim was to improve the knowledge of the natural history of Russia with a view to developing trade and the use of the natural resources of the country. In the same year in Moscow a Society for the Mutual Advancement of the Medical and Physical Sciences was formed. Six years later, in 1811, also in Moscow, the Mathematicians' Society was founded made up of students and former university pupils, who aimed to give free lectures on their subjects and to translate uneful books.(38) In 1816 it was transformed into a college for training officers of the army.(39) A few years later the Mineralogical Society was formed in St. Petersburg in close connection with the Institute of Mining there.

As well as these scientific societies run in close collaboration with the universities and higher institutes and depending on their staff for their membership, there were also a number of scientific societies of a more practical nature. These were run by members of the nobility who wished to modernise their farming methods, and so wanted to learn about new technical and economic improvements. Among societies of this kind were the Free Economic Society of St. Petersburg, already mentioned, and the Moscow Agricultural Society, founded in 1818. In 1822 a college and experimental farm were founded in connection with the latter society with the aim of training qualified workers for landowners' estates.(40)

The next period of scientific activity, the 1840s, gave rise to two more scientific societies:- the Russian

Geographical Society in 1845 and the Archaeological Society. Within both these societies at the end of the 1840s a struggle took place between the foreign and native elements. The Russian members wished to free themselves from foreign domination within the societies and assert their right to their own independent existence. The Russians won this struggle by 1850.(41)

In the 1860s the number of scientific societies increased very rapidly mainly due to the general expansion of the natural sciences, to financial encouragement from the government and to the initiative of Professor Bogdanov of Moscow university. In 1863 he organised the Moscow Society for Lovers of Nature. This expanded to become the Society of Lovers of the Natural Sciences, Anthropology and Ethnography. Branches were formed attached to the various universities.(42) and the society also developed separate sections dealing with different fields such as zoology, botany, chemistry, etc.(43)

In addition to the Society for Lovers of Nature, a number of other specialised scientific societies developed in this period, including the Chemical, Medical and Entomological Societies.(44)

One important aspect of the work of the scientific societies was dissemination of scientific knowledge through the printed word. Periodical publications were the main means of printed communication. All the periodical scientific publications were published under the auspices of the Academy of Sciences, universities or a scientific society. Among such societies producing their own publications were the Free Economic Society, the Moscow Society of Naturalists and the Mineralogical Society. The problems of foreign domination and Russian national pride had to be faced by these societies in their publishing activities. Many of the scientists in Russia in the first half of the 19th century were foreigners and unable to express themselves in Russian, which meant that much of their scientific scholarship was lost to both the educated Russian and the Russian student and scientist. The problem was that if a scientific institution published its proceedings or review in Russian it was only intelligible to Russians and so would help the dissemination of scientific knowledge in Russia itself, but would not help to establish the reputation of Russian science in western Europe; whereas if it published in a foreign language like French, Latin or German, it would achieve fame and approval abroad at the expense of Russian Scholarship.

Most societies, the Academy included, tried to solve these problems by a compromise. They generally published their important theoretical publications in a foreign language, while at the same time producing popular scientific periodicals in Russian for home consumption.(45) After 1860 the position changed radically as the new specialised societies, growing up at that time attached to university departments, nearly all published their proceedings in Russian and most of the older scientific societies began to follow suit. The Academy, however, was one exception: its two chief periodicals, the Mémoires de l'Académie Imperiale des Sciences de St. Petersbourg and the Bulletin Scientifique, continued to be published in a foreign language until 1894, long after the other theoretical reviews had changed to Russian.(46) This fact is a further indication of the lack of interest on the part of the Academy in the encouragement of Russian science, as such.

Despite the increased number of theoretical scientific reviews being published in Russian, the bulk of original scientific papers still appeared during the second half of the 19th century in non-Russian language journals. A survey, based on the Royal society catalogue of 1864 to 1883, of the papers printed by thirty-three leading Russian natural scientists or natural scientists working in Russia in that period - eighteen zoologists, twelve botanists and three geologists[47]- produced the following figures. The total numbers of papers written by these scientists was 535, of which about half had appeared in Russian journals (i.e. journals published in Russia but not necessarily in Russian) and half in foreign. The journals which had the highest number of papers printed in them were all foreign language:- Bulletin Scientifique de l'Académie Imperiale des Sciences de St. Petersbourg (103 papers); Moscou Bulletin de Societé des Naturalistes (96); Zeitschrift für Wissenschaftluke Zoologie (41) Mémoires de l'Académie Imperiale des Sciences de St. Petersbourg (37); Botanische Zeitung (21); Archiv für Mikroskopische Anatomie und Entwicklungsmechanik (17). Russian journals publishing in Russia contained many fewer original papers by these thirty-three scientists. These figures do not give a complete picture since the Royal Society Catalogue did not have access to all the numerous journals being started in this period in connection with the newly formed scientific societies. Sechenov gave much larger figures than those gleaned from the catalogue for the total numbers of scientific researches accomplished in this period.[48] However, the survey does show that Russian scientists were still feeling the need to seek validation for their work from outside Russia.

In addition to periodicals, scientific knowledge was also disseminated through books, and in the first half of the 19th century most of these were again published by the Academy, universities or scientific societies.

The reading public and the number of books published increased steadily throughout this period. Between 1801 and 1806 a contemporary survey listed a total of 1,955 books published;[49] whereas in the five years between 1843 and 1847 the number had risen to 45,793.[50] In this same five year period two million foreign publications were imported into Russia and subscribers of popular monthly reviews numbered around 3,000 to 4,000.[51]

What these figures signified in terms of scientific publications it is difficult to say. The 1801 to 1806 survey broke down the 1,955 books published into the following groups:-

Belles lettres	- 510	Geography and Statistics	-109
Theology	- 309	Medicine	- 97
Philology	- 166	Economics and Technology	- 88
History of Science	- 50	Natural Science	- 66
Military Science	- 27	Mathematics	- 53[(52)]

The figures here for the natural sciences appear to be comparatively healthy, but a look at the publications of individual organisations reveals a less optimistic picture. Between 1803 and 1855 the Academy produced five works on the natural sciences, two in Latin by Pallas and Trinus and three in Russian by Severgin, as well as a number of accounts of various Academy expeditions. Two important translations were done, both by A.F.Sevastianov. They were Linnaeus's "Systema Natural - Kingdom of Animals" and a textbook on geognosy based on Werner's lectures but including the opinions of other geologists.[(53)] The picture in Moscow university was not much brighter. Professor Fischer of the zoology and comparative anatomy departments wrote two books, one in Latin and one in Russian. Professor Richter of the medical faculty wrote a "History of Medicine in Russia" in three volumes between 1811 and 1825.[(54)] It was later translated into Russian.

The number of scientific books published gradually increased however. Despite the vagaries of government censorship private publishing houses were established and these together with the expanding number of scientific societies and scientists guaranteed a steady production of original scientific works and translations during the second half of the century.

<u>The Character of the Natural Sciences.</u>

As has been said before, the actual character of the natural sciences in Russia in the 19th century, such aspects as the quality of the teaching, the type of work being done and the attitude of the public to the natural sciences, were closely linked with the state of higher education and with government attitudes and policies.

The government's main interest in science was generally of a practical rather than theoretical nature. The Academy being the institution closest to the aims of the government, illustrates this point well. Although some of its members did a lot of original theoretical scholarship, especially in the field of mathematics, they were also called upon to apply their knowledge to solving practical problems of the Russian economy. A high standard of theoretical research was regarded as important only in so far as it was a national asset helping to place Russian science on the level of that of other European powers.(55) However, the bulk of the work undertaken by the Academy and encouraged by the government was in the field of exploration and systematisation of Russia's vast natural resources. Karl Ernst von Baer was a good example of this tendency in the Academy. He accomplished most of his important theoretical work in the field of embryology in Konigsberg, Germany. When he settled in Russia in 1834 he switched his main interest to icthyology, physical anthropology, geography and ethnography. He also dedicated a lot of his time to research into the productive resources of Russia, especially the fishing industry, and undertook a number of expeditions in connection with this work.(56) Among other Academicians who made important explorations of Russian natural resources were Peter Simon Pallas and Alexander Middendorff.(57) The government also invited foreign scientists to participate in such exploration. In 1829 Humboldt came to Russia and in 1841 Sir Roderick Murchison led a geological expedition to European Russia and the Ural mountains.

In addition to work done by the full-time Academicians and distinguished visitors, the Academy had a large number of corresponding members, and of these the Russian members would generally number about sixty or seventy at any one time. Since they were scattered all over the vast Russian Empire they were able to provide valuable knowledge of local flora, fauna, minerals etc.

Although the interest of the government in promoting this type of exploration and systematisation of resources might have been practical, the actual work of the scientists on these expeditions was of scientific significance as well. It laid the basis for the very valuable scientific classification of Russian flora, fauna, minerals and geological formations; the members of the Academy were among the first to publish on this subject.

Peter Simon Pallas (Academician)	Results of his 1768-74 expedition	1773-8
	Flora Rossii	1784-8
	Zoographia Rosso-Asiatica	1831
Severgin, V.M. (Academician)	First Foundations of Mineralogy, or the Natural History of Fossils	1798
	An Attempt at a Mineralogical Description of the Russian Empire	1809
Fischer von Walkheim (corres. Academician)	Anomographia[58] Rossii	1821-51
	Oriktographia[58] of the Moscow Region	1837
Middendorff, Alexander (Academician)	Account of his expedition to Siberia	1842-5

In addition, Humboldt published Asie Centrale in 1843 and Murchison published The Geology of European Russia and the Ural Mountains in 1845, based on the findings of their respective expeditions.

The natural sciences did not have, in the universities, the same government support and encouragement that they had in the Academy for a number of reasons. Firstly they tended to be of a theoretical nature and therefore in the government's eyes politically suspect and not of direct practical use. Secondly the main aim of the universities was to provide personnel for the vast bureaucratic machine of the Russian Empire and original scientific research had to take second place. This latter point is well illustrated by looking at the numbers of students studying in the different faculties in Kiev and St. Petersburg universities in 1838:-

Kiev: law - 145; mathematical sciences - 67; philosophical sciences - 55.
St. Petersburg: law - 217; philology - 78; mathematics and natural sciences - 38.[59]

The overwhelming majority of the students studied law and the aim of this faculty was primarily to produce civil servants.[60] Any university student, even if he had not finished his course at the university, was entitled to enter government service, and Law was the most apposite subject for students with such aims. A further confirmation of this fact is seen in the figures of the number of doctors and masters degrees awarded from Moscow university between 1836 and 1854:-

1836-1854	Doctors	Masters	
Hist.-Philos. Faculty	8	20	
Physics-Maths. Faculty	5	15	
Law Faculty	2	7	(61)

Assuming in Moscow a similar distribution of students among the three faculties as in Kiev and St. Petersburg, the proportion of students taking postgraduate degrees was much higher on the science faculty than on the law faculty. The small number of law students studying for higher degrees confirms that they had little interest in academic scholarship for its own sake, seeing the university mainly as the stepping stone to a career in the civil service. The numbers in the science faculty, although comparatively much greater, were still extremely small averaging a total of about fifteen persons taking higher degrees over a period of twenty years. They show that the personnel available for carrying out original scientific research was still extremely limited at this time.

Despite the lack of active government promotion, especially during the first half of the 19th century, scientific scholarship developed slowly within the universities as part of the development of higher education, and often affected by the same problems.

At the beginning of the 19th century the educational expansion was parallelled by an increased interest in science. Table I[62] lists the scientific subjects to be taught at the universities according to their various charters. The 1804 charter shows an enormous expansion with respect to the former 1755 charter of Moscow university. The latter provided for the teaching of only four subjects of a scientific nature, three of these in the medical faculty and one in the philosophical faculty, while the 1804 charter provided for a separate faculty of Physical and Mathematical Sciences in addition to the Medical faculty and the total of scientific subjects accounted for by these two faculties was fourteen.

The need to include the sciences in the curricula at this time was also recognised by other institutions. After 1800 the theological academies revised their programmes to include scientific studies, saying:-

"Since physics, because of its broad scope, cannot be adequately explained by philosophy, it must be treated as a special subject made up of theoretical and experimental parts. For a better understanding of the role of physics in mechanics it is necessary to offer a course in pure mathematics. Finally natural history should be called upon to supplement physics and medicine."(63)

In 1804 the Mining Cadet College, which later became the Mining Institute, widened its list of teaching subjects to include botany, zoology, higher analysis and fundamentals of astronomy.(64)

The staff shortage accompanying this increased interest in the natural sciences could not but affect the quality of the teaching in the universities and other institutes. Many of the foreign scholars, who were invited to Russia to try to overcome this shortage, were unable to speak Russian and had to lecture in foreign languages. Professors Hoffmann and Fischer von Waldheim, who were invited to Moscow university in 1804 and who carried the main burden of the teaching of biological subjects until 1835, were two examples. Professor Hoffmann taught botany according to Linnaeus (and pharmacology) in Latin. Professor Fischer von Waldheim taught the natural history of vertebrates in French and comparative anatomy in Latin up to 1814. He then used Latin, German and

French to teach zoology, mineralogy, geognosy, history of the non-vertebrates and fossils. In this period there were also two Russian professors teaching in the same departments - Dvigubsky and Antonsky.(65) During the thirty years of operation of the 1804 charter, a core of qualified Russian scholars developed, so that when the new charter was introduced in 1835 with its emphasis on nationality the staff situation was radically changed in Moscow. Hoffmann had died. Professor Fischer retained the chair of botany until his death in 1854, but all the other main chairs in natural history disciplines were occupied by Russians.

Despite this fact the number of Russian scientists was still inadequate to fill all the teaching posts in the universities and higher institutes. Consequently scholars often found themselves teaching in two places at once. They also moved from the teaching of one subject to another, which made it difficult for them to attain a high theoretical level in any one subject. G.E.Shchurovsky studied medicine and was an adjunct on the medical faculty of Moscow university prior to his appointment in 1835 to the chair of Geology and Mineralogy. He seems to have learnt about these subjects only after his appointment. Another scientist who began on the medical faculty was Ivan Dvigubsky. In the course of his career he was called upon to teach natural history, physics, technology and finally botany. Ivan Glebov, who was both professor of comparative anatomy and physiology on the Physical-Mathematical faculty and professor of zoology on the Medical faculty of Moscow university commented:-

> " . . . I wrote and published little because I was always having to give lectures on new subjects . . ."[66]

In general the teaching was of a formal rather than practical nature. In the 1820s and 1830s physiology was taught in Moscow through books and with no practical demonstrations. The same applied to chemistry. While he was a student the famous surgeon Pirogov was never called upon to cut up a body for anatomy,[67] and when Glebov was sent abroad to Germany in 1837 to study anatomy he came across methods and instruments he had never seen before. It was the first time he saw and used a microscope and he ordered one to take back to Moscow.[68] However the non-experimental trend generally continued in teaching up to the middle of the 1850s.[69]

1855 signalled the beginning of a period of tremendous expansion for the sciences. Timiriazev described it in the following words:-

> ". . . in some 10-15 years Russian science entered the European family not as a pupil but as a worker of equal status, a collaborator and sometimes as a leader."(70)

In fact 1855 signalled a watershed in the quality of several aspects of the natural sciences - their teaching, their content and their popular image with the public.

A direct illustration of the change in quality of the teaching was given by Timiriazev who described the two professors of botany at St. Petersburg university before and after 1854. Up to that date the professor was Ivan Shikhovsky, a representative of the old systematic trend. His botany textbook for the secondary schools contained more facts than even a doctor of botany would have been expected to know at the end of the 19th century. Once a year he produced a large and unwieldy microscope at his lectures and told his students that it was used for magnifying things. Then, without a demonstration, he put it away again until the next year. When Shikhovsky died in 1854, his place in the chair of botany was taken by Professor Tsenkovsky, a botanist whose methods were on a level with European science and whose special research was into microscopic organisms.(71) The contrast between the two was enormous.

The actual content of the natural sciences in Russia moved from an emphasis on exploration, systematisation or classification and the study of the macro-world, an emphasis represented by the work of the Academy of Sciences, to one on the study of micro-organisms and the searching for wide general scientific theories.

The period 1855 to 1884 was a golden one for the natural sciences in Russia. There was a tremendous increase of vitality in the work of the universities, which themselves became working scientific centres not just teaching institutions as they had been before. Sechenov saw three main results from this increased vitality: a higher level of education and preparation of students; an increase in the number of workers in the natural sciences; an increase in scientific productivity.(72) The science students who had before rarely seen even the door of a laboratory had to undertake practical work as part of their university course.(73) Much of this practical training came in the first place from German universities where many Russian students studied in the 1850s and 1860s. The increase of scientific workers was shown by the growth in the number of scientific societies attached to the universities at this time and also by the organisation of periodical scientific congresses(74) in which hundreds of scientists took part to exchange ideas, discuss mutual problems of research as well as the more general aspects of the role and importance of science for society. The increased scientific productivity was shown by the increased numbers of workers and by the increased numbers of original researches published in this period.(75)

Despite the general vitality of the natural sciences the government attitude seems to have been still rather ambivalent. It did contribute money to the work of the scientific societies,(76) work which was primarily of the practical nature undertaken by the Academy of Sciences. In contrast the government appears to have been less ready to support theoretical research. In Alexander Kovalevsky's correspondence with Anatole Bogdanov, requests for financial help for his trips abroad occur frequently. In 1885 Kovalevsky wrote that he had been abroad four times to do research but not once had either the university or the government offered him any money. Only Bogdanov's Society had helped him a little.(77) However, in his next letter he thanked Bogdanov for getting the Ministry of Education to help him, so clearly it was possible to get government support for this type of research sometimes. In any case the position of theoretical scientific research was much healthier in this period than it had been in the first half of the 19th century because of the increased number of workers mainly centred in the universities and other institutions, where even if they did not receive much direct government encouragement they were at least guaranteed a livelihood and some sort of working conditions.

The 1884 university charter signalled the end of this vital period in the natural sciences. It disrupted the organisation of many universities and higher institutes; some of the teaching became of very poor quality since professors were often appointed for their political rather than their academic qualifications.(78) The scientific congresses that had been held at regular two or three yearly intervals during the 1870s gradually fell off. One was held in Odessa in 1883, four years after the previous one; the next congress, which was also the final one, was not held till 1898, fifteen years later.(79)

The third aspect of the tremendous expansion of the sciences after 1855, mentioned previously, was the popularisation of the sciences and their image in the public eye.

Previous to 1860 there had been little sustained effort at popularisation. In 1801 public lectures were renewed by the Academy[80] and these continued sporadically throughout the century. They were reinforced occasionally by public lectures organised by the universities. Attached to the Academy and universities were a number of museums, libraries and scientific collections but these seem to have been generally disorganised and more for the benefit of members of these organisations than for members of the public.

There were, however, individual members of the intelligentsia who saw science as of vital importance for the future of Russia and who were excited by its possibilities. They believed that science was a progressive force and that the scientific method was the only true one for the investigation of society and the world around them. It was this group of the intelligentsia which sponsored the rational outlook in Russia, in contrast to western Europe where it had been the gentry and merchant class.[81] The main representatives of this trend of thought were

Radishchev, Belinsky and Herzen. Radishchev, who is sometimes hailed as the father of the Russian radical intellectual tradition, fought against mysticism and scholasticism. The works of Pallas suggested to him the possibility of the chemical analysis of the soil and consequent practical improvements in agricultural methods, a question of vital interest to him since it was connected with the economic and ethical aspects of serfdom.(82) Belinsky, who continued the same radical tradition, is best known for his contribution to Russian literary criticism, but at the same time he was interested in the possibilities of science, and there are stories that he used to enjoy watching the building of the first railway in St. Petersburg in the 1840s. Herzen was a friend of Belinsky's. His philosophy of science was part of his whole political philosophy. He was an admirer of Bacon and felt that empiricism and speculation were absolutely necessary counterparts for progress in human knowledge.(83)

The sponsorship of the rational scientific outlook by these leading members of the radical intelligentsia was one of the factors that helped change the popular image of the natural sciences and increase the dialogue between scientist and public after 1855. Other factors were the general expansion of the sciences at this time and the attitudes of the scientists themselves; the latter were young, idealistic and believed in the socially progressive nature of the sciences. Timiriazev wrote:-

> "One of the manifestations of the spirit of the times was the aspiration to find support not only among the representatives of enlightened absolutism . . . but on the more sure foundation of a sympathy to science, based on a more widely spread understanding of its significance and tasks."[84]

Bogdanov's Society for the Lovers of Nature was one example of this spirit since he aimed at forming a society that would appeal to non-specialists as well as to the specialists, and so would help to popularise the sciences.[85] The Society was meant to play a role that the fifty-year old Moscow Society of Naturalists had failed to fulfil. The latter had made little attempt to communicate an understanding of the sciences outside the small circle of its specialist members. They usually met once a month to listen to one or two papers on various branches of the natural sciences. Sometimes the papers were so specialised that only two or three members could understand and the rest would sit round drinking tea and looking at reviews. The Society's bulletins were published in French, German or Latin and so they were better known abroad than in Russia. ~~The~~

The Society's chief merit was that it did have a very good library of foreign periodicals. The only time when the Society had attempted to break out of its small circle and popularise the sciences was on the initiative of K.F.Roullier, professor of zoology at Moscow university. In 1854 he founded, under the auspices of the Moscow Society of Naturalists, a popular scientific review <u>The Herald of the Natural Sciences</u>. However, this did not survive long after his own death in 1858.(86)

Other examples of popularisation were the founding and opening of museums to the public, the publication of popular scientific books, both original Russian and translations, public lectures and demonstrations, regular articles on science and discussion of scientific ideas in the popular monthly reviews, the organisation of Sunday schools (secular not religious) which were open for people of all ages and positions but were mainly attended by the poor and working classes who had no education, and the organisation of courses of higher education for women. From 1860 on, popular scientific knowledge became available to a much wider general public than it had ever been before. This helped the actual development of scientific research in the universities as many future scientists were first attracted to science by the popularisation that took place in the late 1850s and 1860s.

The pattern that emerges from looking at the development of the higher educational system and the natural sciences in the 19th century is of a steady quantitative expansion marked by a definite qualitative change, especially with regard to the natural sciences, in the middle of the 1850s. The qualitative change signalled the coming of age of the natural sciences; it was a period when they moved from being the poor relation of west European science, always dependent on an injection of foreign blood and ideas, to the position of an equal, able to participate in, contribute to and sometimes lead contemporary sciences. The fact that this period of confident, dedicated and eager work coincided with the publication of Darwin's Origin of Species was a significant factor for the reception of Darwinian concepts in Russia.

CHAPTER III

The Theoretical Concepts Present in the Natural Sciences in Russia Prior to 1859.

Although the natural sciences in Russia in the first half of the 19th century were predominantly concerned with the need for their own organisation and development - aspects such as the collecting and collating of scientific material, teaching, translating and introducing scientific terms into the Russian language - there was also present scientific work of a theoretical nature; the interpretation of scientific facts and speculation existed alongside empiricism. The theoretical traditions established at this time had a definite significance for the reception of Darwinian concepts in Russia.

Prior to the publication of the Origin of Species in 1859, scientists in the fields of biology and geology in Europe and America worked primarily within the framework of a belief in special creation. Cuvier, who was perhaps the most famous exponent of this idea, believed that each species had been separately created and was immutable. He also advocated the parallel view in geology - catastrophism. According to this theory every major geological feature such as a range of mountains or deep chasm had been formed abruptly by supernatural catastrophic forces, forces much stronger than any visible on the earth's surface.

Although the ideas of catastrophism and immutability of the species dominated in the first half of the 19th century, alternatives were also posed. Lamarck put forward the idea that species were not unalterable and that the more complex had developed from pre-existent simpler forms; a more limited concept of the mutability of the species was held by Etienne Geoffroy Saint Hilaire, who searched for a unity of organic composition. In the field of geology the alternative was the uniformitarian theory, first formulated by Hutton and Lyell in Britain, which presumed that the present agents acting on the earth's surface, agents such as wind, erosion, action of rivers etc., were quite adequate to explain the geological changes that had taken place in the past.

The uniformitarian theory was more scientific than the catastrophic theory since it depended on natural rather than supernatural explanations, and by 1859 it was accepted as a working hypothesis by most geologists even though they hesitated to come to terms with the tremendously long time scale it demanded, a time scale which clashed with the truths of genesis.

The problem for transformists, the followers of Lamarck and Geoffroy Saint Hilaire, was that, unlike the uniformitarians, they had no satisfactorary scientific mechanism to explain the transformation of one species into another. They had to wait for Darwin to provide this. At the same time the ideas of the transformists were not totally devoid of credence, since there were a number of scientific facts difficult to reconcile with the theory of special creation.

The vast programme of exploration during the 18th and the first half of the 19th century brought to light a large number of new speies, sometimes, as was true of those found by Darwin on the Galapagos Islands, differing only in small details one from the other. In this case it seemed to Darwin to be much more probable that these different species had all developed from one common source alive at the time that the islands had broken away from the mainland, than that they had each been created separately. Asa Gray and Joseph Hooker did in fact, prior to 1859, both come to the conclusion that there was a possibility for greater variation in species than was generally allowed for by the theory of special creation. The growing number of species known to biologists also created a problem in the sphere of classification because of the difficulty of distinguishing between species and varieties.

In the field of embryology again there were a number of facts easier to accommodate to a transformist theory than to the theory of special creation. The early stages of embryonic development of animals of the same group displayed such close similarities that it was sometimes difficult to distinguish between them, thus apparently pointing to some type of affinity between them. Similarly the fact that ontogeny was the recapitulation of phyllogeny, first discovered by Von Baer and Agassiz, indicated an historical development of the species rather than their special and sudden creation.

In the field of comparative studies, discoveries of anatomical, morphological and other similarities between animals of the same groups could be explained by transformist theories, though the special creationists saw these similarities as different representations of an ideal type and not necessarily historically related in any way. In their formulation of the cell-theory in 1839 Schleiden and Schwann provided one basic building material for the whole organic world, but again although it could be accommodated within a theory of evolution this factor could also fit in quite successfully with the theory of special creation.

In Russia the theoretical ideas present in the fields of biology and geology have to be seen both in relation to such ideas in western Europe and in their significance for Darwin's theory of evolution.

Among Russian biologists, those with the highest international reputations worked in the field of embryology. In fact the three most famous embryologists of this period - Caspar Friedrich Wolff, Christian Pander and Karl Ernst von Baer - all had connections with Russian science.

Caspar Wolff was elected to the Imperial Academy of Sciences in 1766. Seven years earlier he had published his important embryological work <u>Theoria generationis.</u>

in which he refuted the theory of preformation and replaced it by the correcter doctrine of epigenesis or after-formation. This latter theory stated that the development of the embryo consisted of the gradual production and organisation of parts, whereas the preformationists supposed that the future animal was already present in miniature in the germ cell of the embryo. Wolff's influence really dated from the year 1812 when Meckel translated one of his treatises and thus drew attention to its great merit.(1)

Christian Pander, who studied at Dorpat university and in Germany, and who was a member of the Russian Academy of Sciences from 1821 to 1827, published his researches into the development of the chick embryo a few years later in 1817.(2) In his work he gave "a fuller and more exact view of the phenomena less clearly indicated by Wolff, and laid the foundation for the views of all subsequent embryologists."(3)

Karl Ernst von Baer was the most famous of this trio of embryologists. He was born in 1792 and, like Pander, studied at Dorpat university. He later went to Germany where, in the 1820s, his comparative embryological studies demonstrated completely the truth of epigenesis.

Those researches showed the similarity between the early stages of the embryos of different animals; in fact it was impossible to know to which species or group the embryo of the vertebrate belonged.

The establishment of the theory of epigenesis and these comparative embryological researches were important stepping stones towards the formulation of a scientific theory of evolution. Darwin regarded Von Baer as one of his forerunners and quoted the latter's observations in the Origin of Species in support of the theory of evolution:-

> "So again it has been shown that generally the embryos of the most distinct species belonging to the same class are closely similar, but become, when fully developed, widely dissimilar. A better proof of this latter fact cannot be given than the statement of Von Baer that 'the embryos of mammalia, of birds, lizards, and snakes, probably also of chelonia, are in their earliest states exceedingly like one another both as a whole and in the mode of development of their parts; so much so, in fact, that we can often distinguish the embryos only by their size. In my possession are two little embryos in spirit, whose names I have omitted to attach, and at present I am quite unable to say to what class they belong. They may be lizards or

> small birds, or very young mammalia, so complete is the similarity in the mode of formation of the head and trunk in these animals. The extremities, however, are still absent in these embryos. But even if they had existed in the earliest stage of their development we should learn nothing, for the feet of lizards and mammals, the wings and feet of birds, no less than the hands and feet of man, all arise from the same fundamental form.'"(4)

Von Baer himself was a transformist, as was Pander and even Wolff of a sort.

The ideas of these three eminent embryologists were important for the reception of evolution in Russia for two reasons. Firstly the development of the theory of epigenesis was an important factor in the establishing of the genetic and historical links of different species. Secondly all three were convinced of the mutability of the species in some limited way at least. Although they worked in the Academy of Sciences in St. Petersburg the ideas of Wolff, Pander and Von Baer were not necessarily known to the Russian public nor even to Russian scientists. Their works were all published in German or Latin; much of their original research was done outside Russia in Germany. Nevertheless their ideas do not seem to have been foreign to Russian biologists, although the latter approached the question of transformism more from their study of the macrocosm than from the field of embryology.

As was pointed out in chapter II, Russian biologists and geologists of this period were concentrating their researches on the macrocosm, on the collection of material about the natural history of their country. Although their material was by no means complete they did attempt to collate and classify it from the very beginning,(5) and one of the first to do so was Peter Simon Pallas, a German by nationality. Pallas had studied the natural sciences in Germany, Holland and England before coming to Russia in 1767 on the invitation of the Academy of Sciences. He lived most of the rest of his life in Russia, but died in Germany in 1811. During his expeditions he collected a large amount of material in the fields of geology, botany, ethnology, zoology and palaeontology. His most important work was <u>Zoographia Rosso-Asiatica</u>, which was published in Latin twenty years after his death, but was never translated into Russian.

Both Pallas and a number of other biologists who attempted to classify the Russian fauna and flora, tried to use a natural method rather than the artificial Linnaean system. In the field of zoology Pallas classified the Russian fauna taking into account their inner structure, seasonal variations and geographical distribution.(6) Mikhail Maksimovich, who was a botanist at Moscow university, felt that the spiritual life was more important than outside appearance for true classification.(7) Similarly Severtsov felt that there was little use in classifying animals according to their skins and skeletons if this told one nothing about their life.(8) K.F.Roullier, who taught zoology at Moscow university from 1840 to his death in 1858 and with whom we shall be dealing in more detail later, criticised contemporary methods of classification saying:-

> "I want to classify an animal as something that is a whole and complete animal, not a part of one. And therefore, in order to have an adequate basis for the confirmation of the existence of a species I must survey the whole mass of separate phenomena, which make up the full history of the animal. In order to disclose this we remind ourselves that the animal exists A) in space and B) in time."(9)

He made this point because what may form the basis of the difference in one case was not necessarily valid in a different case. In fact the definition might depend on whether man had watched the species develop or not. Roullier cited the example of dogs: many types of dogs are more dissimilar than two wild animals which man has classified as belonging to two different species. The dogs, however, were placed in one species because man had seen them develop.

Along with these various attempts at a natural classification there also existed methods of classification which followed the Linnaean system.(10)

In Russia, as in other countries of Europe at this time, there was a certain despair over the possibility of ever being able to classify the natural world satisfactorily. The continual discovery of new species and the difficulty of distinguishing between a variation and a species led the academician Johann Brandt to write in 1856:-

> "In general the introduction of new European species is a thankless task; it demands extreme care, a mass of material and extensive study . . . Let us hope that in the not too far distant future naturalists will agree on some general rules for assessing the characteristics of a species. Then

> they will be able to simplify matters and eliminate the chaos, at present reigning over the question of defining a species, by throwing out a good deal of the synonymous ballast. In order to do this it will obviously be necessary to devote as much attention to the inside structure of animals as to their outside appearance. And then by many-sided comparisons it will be determined accurately and clearly which characteristics must be considered permanent and which temporary."(11)

The main questions raised by the problems of systematics were in Russia, as elsewhere, those of the fixity of the species and their definition.

The ideas of all the most famous west European scientists in this field were known to the Russians, either through their original works or through translations of them. Catherine II read Buffon's <u>Natural History</u> when she was very young and ordered that it should be translated into Russian. Later in the century in the period of political reaction the church censorship suppressed the publication of his <u>Epochs of Nature</u>. In 1800 Linnaeus's <u>Philosophica Botanica</u> was translated into Russian. Lamarck's ideas were known through the work of Pander(12) and they were further disseminated to a wider public through Dvigubsky's New Journal of Natural History, Physics, Chemistry and Economic Knowledge.[13] Cuvier's ideas were also known but it seems that neither his works nor those of Lamarck were fully translated into Russian. Neither (prior to 1859) were those of Geoffroy Saint-Hilaire, but in 1843 an article appeared in Belinsky's review Notes of the Fatherland which dealt with his ideas in detail,[14] and treated them with great sympathy in comparison with the ideas of Cuvier. Articles written by Russian biologists in the 1840s and 1850s contain many references to Saint Hilaire's ideas. They do not seem to have been affected by his defeat at the hands of Cuvier in 1830. The concepts of naturphilosophie, dominant in Germany at the beginning of the century, were also present in Russia for a short time.[15]

In Russia the dominant trend in the discussion over the mutability or immutability of the species was that of transformism and there seem to have been few firm supporters of Cuvier's theory of catastrophism and the fixity of the species.

The trend to transformism can be traced back to the eighteenth century. As mentioned earlier Caspar Wolff, the embryologist, could be considered a transformist of sorts. He regarded a species as more than just an aggregate of morphological characteristics, a conception which was in opposition to the systematic ideas of Linnaeus. Wolff also thought that new species could and did emerge from old ones.(16)

A more important figure of the 18th century in this field was Peter Simon Pallas. He was a firm believer in the fixity of the species, but the large number of varieties he met with on his various travels led him to develop two hypotheses concerning this problem. Firstly, he thought that all variation was due solely to the crossing of either distinct races or distinct individuals belonging to the same race. Secondly, he developed the hypothesis that closely allied species, which in a state of nature or when first captured would have been in some degree sterile if crossed, lose this sterility after a long course of domestication.(17) Both hypotheses had a certain relevance for transformist ideas. The first described a possible mechanism for the production of new varieties, and, if varieties could be produced through crossing, then there was a possibility for species to emerge in this way too. The second hypothesis placed the definition of a species and their fixity on quicksands. Right up to and after 1859 one defining characteristic of a species was that the members of one species should be unable to cross with the members of another species and produce fertile progeny. Pallas's hypothesis introduced a time element into this definition of a species by saying that in the course of domestication the progeny of two species could become fertile. Darwin himself refuted the first hypothesis but thought that the second one was "extremely probable".(18) In addition to these two ideas, which were by no means rigidly in support of the immutability of the species, Pallas drew up a tree of life which showed plants and animals as two kingdoms branching out from the same lower organism, the zoophyte. Mechnikov thought that Pallas regarded his tree of life as an ideal relationship between the species(19) and this view coincides with the fact that Pallas believed in the fixity of the species.

The main point to be made with regard to the ideas of Pallas on this question is that although he himself believed in the immutability of the species, many of his ideas and much of the work he did in the fields of botany and zoology could be used in support of transformist ideas as well.(20)

Von Baer, on the other hand, who was the most eminent biologist working in Russia in the first half of the 19th century, was a convinced transformist throughout his life. Philosophically and historically Von Baer stood between the extreme morphological views of Cuvier and the extreme evolutionary ideas of Darwin.(21) He introduced the principle and aspect of development into his embryological studies, a principle and aspect which was excluded by Cuvier with his strictly morphological and comparative anatomical approach. At the same time he arrived independently at Cuvier's conception of four animal types; the vertebrate, mollusk, articulate and radiate. Von Baer limited the range of transformism to each animal type, one type being unable to transform into another. Yet Von Baer thought that all four types had a common origin and in his History of the Development of Animals, published in 1828, he suggested that embryology might be able to throw light on the type of organism that had first existed and out of which the present animal world could have developed:-

> "But as the embryo itself is an unformed animal, one can with good reason suppose that the simple form of vesicle is the common primary form out of which all animals develop, not only conceptually but historically."(22)

However, as far as real embryos went, he was certain that "the embryo of the vertebrate animal is from the very first a vertebrate animal, and at no time agrees with an invertebrate animal.(23)

On the eve of the publication of the Origin of Species Von Baer wrote an article in the Memoires of the St. Petersburg Academy of Sciences in which he expressed his conviction that there was geographical proof of the variation and evolution of the species within their types.

> ". . . it happens so often that the groups of animals under observation are blood related groups that it seems to me one can say that here there is basically a real relationship and that groups that are similar to each other actually do have a common origin and arise one from the other. I think that it is possible to infer from the distribution of animals that many species, which now develop separately, were at first undivided and that thus out of variations arose specifically different species . . ."(24)

Although his work was generally little known outside Germany and Russia it was, as we have seen earlier, well known to Darwin, who referred to these ideas of Von Baer's in his historical sketch at the beginning of later editions of the Origin of Species:-

> "Von Baer, towards whom all zoologists feel so profound a respect, expressed about the year 1859 (see Prof. Rudolph Wagner, Zoologisschen-Anthropologische Untersuchungen, 1861, s, 51) his conviction, chiefly grounded on the laws of geographical distribution, that forms now perfectly distinct have descended from a single parent form."(25)

Von Baer himself did not regard his transformist ideas as in any way unusual. When looking back on the period of the 1820s and 1830s he wrote:-

> "In general I believe that at that time, when the succession of different animals and plants in the history of the earth - and generally from imperfect to more perfect organisms - occupied the thoughts of naturalists, and when at the same time, the study of development of single organisms had taken a new start, the notion of their Transformation was pretty generally accepted."(26)

This reminiscence of Von Baer, which would have chief relevance to German, and perhaps also Russian, biologists of the period, illustrates the role of German naturphilosophie in giving scientists a sense of the principles of unity and development in nature.

The most important indigenous Russian scientist, working in Russia and writing in Russian, who represented and developed this tradition of transformism was K.F.Roullier. Karl Frantsovich Roullier came from a French immigrant family, but it is not known when it settled in Russia. There are no references to his father; his mother, who lived with him all her life, was a midwife by profession. Roullier was born in Nishny Novgorod (the present day Gorky) in 1814. He received his primary and secondary schooling there, and then in 1829 he went to Moscow to study at the Medical Surgical Academy. He qualified in 1833 and spent the next three years working as a doctor in the army. In 1836 Professor Fischer von Waldheim invited him to become a coach at the Medical Surgical Academy, where he soon began to teach mineralogy and zoology independently as a junior scientific assistant. At this time he was also head of the cabinet of natural history in the museum of Moscow university. In 1840 he started teaching zoology at the university itself. Two years later Roullier was elected to a lectureship and in 1850 he became professor of zoology, in which post he remained until his death in 1858.

In 1841 Roullier was sent abroad for four months to Holland and Germany by Moscow university. He visited the main scientific centres and the trip was a decisive point in his career. Although Roullier was impressed by the enormous funds of knowledge he saw and heard in western Europe, he was also struck by the absence in teaching and writing of any deep consciousness of the need for building zoology as a science. He expressed his ideas in an article entitled 'Doubts about Zoology as a Science' published in Belinsky's popular review <u>Notes of the Fatherland</u>. The main point with which Roullier seems to have been concerned was the need to find general zoological laws to bring together the many disparate branches of zoology.

For Roullier himself one of these basic general laws was the need to approach zoology from an historical and development view point. He was convinced that "each phenomenon does not exist as such from nature, but as such because it has passed through a number of consecutive changes; and it is itself only the expression of a long series of successively varying phenomena and the member of a future endless series of new phenomena. It is obvious that science, which is searching for a sound method of research, must follow the conclusion that arises from such a view of the outside world: the scientific method is the experimental study of the object or phenomenon in its successive development, not as single isolated unit, but as one necessarily linked with other outside phenomena in relation to itself."(27) This idea of constant movement and development in the organic world, and of the consequent need to look to the past in order to understand the present, runs as a leitmotif throughout all Roullier's works.

In Roullier's specific ideas on transformism we find concepts similar to those of Von Baer. In a public lecture he gave in 1851 he described the animal world as being divided into four separate types:-

> ". . . at first there suddenly appeared the animals - the radiata, the mollusks, the arthropods and the vertebrates. The first, as in present day starfish, have their one chief organ in the centre of the body; the other organs are distributed in rays close to it. The second, like our snails, have an invertebrate, mucilagenous body without limbs. The third, like our crabs and insects, had an invertebrate body divided across into seg-

> ments and jointed appendages. The latter group had articulated bodies based on a vertebral column or its appurtenances. These four divisions of the animal world make up its basic forms, and all, together, are equally necessary for a balanced organic life. History shows that at one time, and in this there is no difference with the present, the animal kingdom was primarily one harmonious organism."(28)

Thus Roullier, like Von Baer, conceived of the animal world as being made up of the same four basic types. Further on in his lecture he went on to say that all the species living at the present moment have developed from these four basic primary forms. He postulated as a general law the concept that plants and animals should gradually change in form and also move from one medium to another. He cited as examples insects, many of whom start their life in water and then move to dry land, and all land animals, including man, who begin life in a liquid medium. Roullier felt that there were certain parallel orders in the organic world. First there were the prehistoric orders representing the primary forms of animals. Second there were the genetic, or evolving, orders which covered the contemporary species that had evolved and were evolving from their primary form. Thirdly Roullier introduced a final order to cover those contemporary animals which were fully developed, had stopped changing and could be considered as perfected forms. Thus it seems that Roullier believed that each of the four basic forms of the animal world had a potential for development and change but that there existed a limiting perfect and final form. Whether this meant that in the end the animal kingdom would develop into four perfect animals representing the four basic types Roullier did not say.

Like Von Baer, Roullier also turned to embryology for help in discovering how species developed. He saw the development of a group of plants or animals reflected in the development of a single individual:-

> "At one time the historical appearance of organic beings on the earth followed the same path which we observe today in the development of a plant or animal: the nearer to the time when beings first appeared and the nearer to the first beginning of a single being of our time, the less difference there is and the more alike among themselves are all kinds of beings; and clearly this is because they all - both plants and animals - are generated from one primary similar form - the cell. Development is the gradual apportionment of variety and opposites."(29)

This passage has similarities to that of Von Baer on development from a single vesicle,[30] and like it could imply that the author believed that the organic world had evolved from a single primary cell.* However in both these cases it is clear that Von Baer and Roullier believed in limited transformism within certain types, and for them the cell or vesicle must have been regarded as a primary structural unit of organic matter rather than as a primary form.

Von Baer and Roullier were not the only scientists working in Russia who had transformist ideas, nor did their concepts cover the totality of ideas present in this field in Russia in the first half of the nineteenth century. Among those scientists who developed some form of transformist concept, however, their ideas are very representative of the general trends.+

Those scientists who supported the fixity of the species were not very articulate or firm in their views. A

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* The idea that the simple vesicle, the primary stage of the embryo, was the basic form from which all the species have developed, was not present in Darwin's writings at all. It is an idea perhaps closer to Haeckel where the comparative stages of evolutionary and embryological development are seen as having a definite and real relationship.

+Other biologists with some form of transformist ideas were Maksimovich, Shchurovsky, Severtsov, Rachinsky, Usov, Bogdanov, Borzenkov at Moscow and Kutorga and Zheleznov at St. Petersburg.

good example is Stepan Kutorga, the professor of zoology at St. Petersburg university. He was at first a supporter of Cuvier; later he tried to combine the catastrophic theory with the idea of the evolution of organisms within the limit of each geological period; ironically it was also Professor Kutorga who was the first person to acquaint the St. Petersburg students with the ideas of Darwin in a series of lectures he gave in autumn 1860. This situation illustrates very well the shaky position of catastrophism and the theory of special creation in Russia and meant that there was no well established basis for a strong scientific opposition to Darwin's ideas.

An example of the typical ideas present in Russian biology concerning the question of transformism and the fixity of the species around the time of the publication of the Origin of Species can be found in an article written by N.A.Severtsov, a pupil of Roullier's, in 1860.(31) The article, 'Zoological Ethnography', dealt with a large number of questions among which was that of the fixity of species. Severtsov began by critically discussing the views of a large number of naturalists: Buffon, Lamarck, Isidore and Etienne Geoffroy Saint Hilaire, Lyell, Cuvier, Vogt, Gloger, Reichenbach, Blasius, and Chamber's book Vestiges of the Natural History of Creation. He was critical of all views, saying that neither proposition - the fixity of the species advocated by Cuvier, nor the mutability of the species advocated by Lamarck - had yet been proved. Severtsov himself, like many Russian biologists, leaned towards the views of Etienne Geoffroy Saint Hilaire:-

> "The facts introduced by Cuvier only demanded that out of Lamarck's position of infinite variability was removed the idea of infinity; this was done by Geoffroy Saint Hilaire."(32)

In this article Severtsov made the point that it is impossible to prove definitely either the mutability or the immutability of the species without first defining accurately what a species was, and he felt that this had yet to be done. All the same, again like the majority of Russian biologists, he felt more sympathy for the concept of mutability than for that of immutability. A few years earlier he had written:-

> "A species is an organic totality or organic being like an individual . . . It has its own age, its own consecutive phases of development; and it changes as a whole, as E.G.Saint Hilaire said. During the succession of generations the species

> gives birth to new species, which at first are individual variations and then transform themselves into permanent races - at the first stage these are joined by intermediate forms, but in the end they become completely separated. Whether the primary form survives, together with its offspring, or dies out depends on the surrounding conditions of life. However these diverging types always retain in their characteristics a trace of their common origin, and they are more like each other than neighbouring types of the same family which may reproduce in an identical way."(33)

That transformism was a dominant trend in Russian biology both prior to and around the time of the publication of the Origin of Species is clear. Yet it faced the problem that any theory of transformism, however limited, prior to Darwin had to face, the problem of a cause or mechanism to explain the variability of the species. That is, how was it possible for one species to change and develop into another, and what was the mechanism of this process? Prior to 1859 a number of hypotheses were suggested attempting to answer these questions: the influence of the surrounding conditions, the inheritance of acquired characteristics, the crossing of two distinct individuals or races, the

the action of an inner vital force and others.

Pallas, as stated earlier, believed in the third of these propositions and developed the hypothesis that all variation was due solely to the crossing of either distinct races or distinct individuals belonging to the same race.

A dominant hypothesis among Russian transformists, however, was that of the influence of the environment.* Von Baer expressed himself on this subject in rather vague terms in an unpublished work he wrote in the 1820s:-

> "New organic forms in an advancing degree of perfection are gradually formed on the earth, perhaps in the course of thousands of years. Consequently, new forms arose gradually, and if, at present, we do not observe the appearance of higher animal forms, then we can only conclude that the conditions, which gave rise to them, have changed. For a long time the first animals were only water animals. Every land animal in

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*Malthus' theory was known in Russia before 1859. In fact in his article 'Harmony in Nature' Beketov pointed out the large discrepancy between the numbers of plants and animals born and the numbers that survive. However there is no evidence that any Russian scientist saw the relevance of these facts for the mutability of the species.

> the present period, even though it is reproduced from parents of its own species, begins its life history with the embryo feeding on liquid substances. Therefore the first appearance of life took place in water, and that is much more understandable than if the origin of life had taken place on dry land. The latter would be incomprehensible according to the general conditions of animal life and would have to be regarded as a new act of creation . . . It is possible to suppose that land animals arose by means of gradual transformation from water organisms."(34)

Later on in his autobiography Von Baer brought this point out more clearly when discussing Darwin's theory of evolution. He noted that he himself laid more stress on the influence of the conditions of existence on variation in organisms than on the struggle for survival and survival of the fittest.(35)

Roullier, however, defined his views on the influence of the surrounding conditions on organisms very clearly. Like the concept of development, the concept of continuous unbroken interaction between all things runs as another leitmotif through his work:-

> "There is no peace in nature, no stagnation . . . In nature there is general unbroken movement, absolute death is not possible. The very smallest grain of dust, lying in the centre of a continent or sea, has influence on its surroundings and is itself influenced by them."(36)

Roullier found material in support of his ideas in the fields of geology and geographical biology:-

> "Animals find themselves under the constant influence of the activity of the outer world. This cannot be better illustrated than by their different geographical distribution, by the excellent structure of each animal in relation to the outside conditions, by their regeneration or degeneration when moved from one type of surroundings to another . . ."(37)

Roullier was convinced of the basic importance and widespread generality of this phenomenon. He felt that it was one of the basic laws governing the organic world and he formulated a general law to that effect:-

> "The First Basic Law of Historical Development. The whole history of an animal (as of anything that really exists) shows without doubt that an animal, placed at its own disposal, separated from the outside world, can neither be born nor live nor die. The mutual participation of two kinds of elements, those belonging to the animal and those which are outside of him, are necessary for the

> completion of a full circle of growth. The law of the duality of living elements or the law of intercourse of the animal with the world - this law has the most general and universal significance."(38)

When he applied this law of the duality of living elements to the process of transformism or evolution, Roullier clearly saw a continuous battle going on within each organism - between the processes taking place within the organism and those taking place outside of it, between the conservatism of the species and the influence of the changing environment, between the law of stability of form and the law of mobility of form. The changes brought about in the organism as a result of this battle could, he thought, be passed on by heredity:-

> ". . . The influence of the outside world on the animal kingdom is extremely profound, so much so that after a certain time it is consolidated for posterity, it is made hereditary."(39)

Since Roullier believed that transformism took place and that the influence of the environment was the agent bringing it about, it was logical for him to conclude that the characteristics acquired under the influence of the environment or through conditions of life would be hereditary.

Ideas similar to those of Roullier were put forward by Andrei Beketov in 1860. Beketov was a botanist working in St. Petersburg university, who had studied as a student in Kazan university. It is unlikely that he had come under the direct influence of Roullier and yet he had entertained many similar ideas on the relationship of the organism to the environment. In an article, 'Harmony in Nature', written in 1860(40) Beketov rejected the teleological view of nature. He said that all living forms were dependent on all others and the surroundings formed the mould into which the new organism was poured. In fact, in his view, the reason for the structure, outside appearance and whole essence of each being lay in its surrounding conditions, and in dependence or harmony with these surroundings. He compared this process with that of the building of a steamship. The steamship was built to give man a fast means of transport, but that was not the reason for its actual structure which depended on the laws of nature.(41)

This tendency to see the influence of the surrounding conditions as the agent for the process of transformism was not, of course, totally widespread in Russia prior to 1859. It was, however, an important tendency especially in so far as it affected the development of Russian biology after that date and the reception of Darwinian concepts.

Scientifically the concept of the influence of the environment on organisms, or of the mutual interaction between organisms, was a concept used primarily in two branches of biology - ecology or geographical biology and physiology.

In Russia it was the former field that provided most of the material for and helped nurture the concept of the influence of the environment on organisms prior to 1859. The ideas of the German school of physiology, the rejection of vitalism and the creation of a mechanistic view of nature where all organic processes had a materialist or factual cause, and where the influence of the environment acted directly on the object, both physically and mentally, did not take strong root in Russia until the end of the 1850s.(42)

Ecology or geographical biology, the study of plants and animals in relation to their environment, however, had developed earlier in Russia. The founder of this tradition was Pallas, who in his natural classification of the vertebrates distinguished, and was the first to do so, between varieties due to climate and species. He always turned especial attention to the influence of the environment on animal life. Humboldt, who worked in Russia for a short time, laid the basis for two new sciences, important for this field: physical geography and climatology. The application of Humboldt's researches in these two sciences to animal life was taken up by another German, C.L.Gloger, whose main work was on the climatic variations of birds. Although he never worked in Russia, Gloger thought that Russian scientists would be able to achieve much in the field of zoogeography since large tracts of the Russian Empire were still virtually untouched by human hand and since there were tremendous variations in climate.(43) And, in fact, the various expeditions undertaken in this period collected material from the different climatic zones of Russia which was invaluable for this science.

The first real scientific studies made in geographical biology in Russia were by K.F.Roullier and his pupil Nikolai Severtsov. In 1850 Roullier published a monograph entitled 'Where does the town swallow fly to?'

He based his method of research on the idea that "in evaluating the phenomena of the organic world, one must turn one's attention primarily to the multiplicity of causes of and to the course of the phenomenon, which consequently depends on: 1) the animal or plant organism; 2) all the complexities of the outside conditions: climate, the locality, food, safety; 3) the whole series of preceding vital phenomena of the plant or animal being studied; a series in which every phenomenon depends on the preceding one and conditions the following one."(44) Although interested in the methods of ecology, Roullier himself did not do much original work into it. It was his pupils who established ecology as a science in Russia. Severtsov's doctoral thesis on "Periodic Phenomena in the Life of Animals, Birds and Reptiles of the Voronezhsky Region" is cited by Russian historians as the first ecological study to appear in Russian. Severtsov followed Roullier's method, but perhaps he emphasised even more the role of the surrounding conditions, and, unlike Roullier, he dismissed any possibility of the role of instinct in determining animal behaviour.

Another pupil and follower of Roullier in this field was Anatole Bogdanov, who studied at Moscow university and in 1858 became professor there. Bogdanov was an organiser rather than a theoretician, but in what scientific work he did he approached it from a very similar viewpoint to that of Roullier. He dedicated his first lecture at Moscow university to Roullier and in it showed the significance of ecology for biology as a whole:-

> "The study of the life of the animal in all its apparent diversity, the study of the affinity of the separate types of the animal kingdom and of the relationship of their structure to their way of life, research into the historical development of animal life on the earth, into the first members of that chain, the last link of which is manifested to us by the geographical distribution of animals today, and finally the search for general laws ruling the zoological world - this is the variety of points of view that make up the content of our science."(45)

The 1804 university charter created a department of mineralogy and agriculture which introduced the discipline of geology into the university curriculum for the first time. Geology had also been taught in the Mining Institutes since the 18th century. In that century the practical aspects relevant to mining were mainly emphasised, but Lomonosov, the great indigenous scientist of that period, advocated a type of uniformitarian viewpoint saying that the earth had undergone great changes since its beginning and that these changes could be explained by geological processes going on at the present time.(46) His method was used by a number of Russian geologists at the beginning of the 19th century including Dvigubsky, Lovetsky and Perevoshchitsov, all professors at Moscow University.

At the same time the posts created by the new university charter had been mainly filled in the majority by German scholars, many of whom were pupils or followers of Werner(47) his Neptunist theory was at that time the dominant geological theory in Germany. The invited German geologists and mineralogists established a certain following for Neptunism in Russia, but these concepts do not appear to have ever had total dominance and must have existed side by side with the more uniformitarian views of native Moscow professors.

In 1810 the Academy published the first text book on Geognosy* to be written in the Russian language. It was

*The word Geognosy was used by Russians quite frequently in the first half of the 19th century with the meaning of geology. It probably came from the French work Géognosie.

not an original work but a translation of the basic ideas of Neptunism as set out by Werner in his notes to his lectures given in the Freiburg Mining Academy. The translator, Alexander Sevastianov, did not change any of Werner's text but he did include in the book the opinions of a number of geologists who disagreed with Werner. This helped in the development of anti-neptunist ideas in Russia.[48] In 1829 Professor Fischer von Waldheim wrote that fossils were the remains of animals and not sports of nature as Werner maintained. He also thought that on balance it was more likely that fossils were formed naturally rather than by some sudden cataclysm:-

> ". . . but in general we see that the more our knowledge expands and becomes clearer, the less do we need supernatural causes to explain geological facts. If we do not yet know the causes of some phenomena, we shall wait for the time when, through increased facts and the acquiring of exact and detailed material, the proper explanation will present itself."[49]

In general the Neptunist theory had lost any dominance it had by the 1830s when the geology of Russia was becoming more widely known and it could be seen that the facts corresponded better with the Vulcanist than with the Neptunist theory.

The work of the Russian geologists, unlike that of the biologists, began to gain European interest and recognition quite early. A geological society was founded in 1817 and in 1825 it began publishing the Mining Review as an organ of the society. The influence of this review quickly spread abroad. In 1829 Humboldt made his expedition to the Urals, Altai and Caspian Sea. Ten years later Leopold von Buch[50] wrote an article, based on a collection of fossils that the Mining Institute in St. Petersburg had sent him, in which he assessed the work of Russian geologists of the period and compared the geological formations of Russia and Europe.[51] This article aroused the interest of the British geologist Roderick Murchison, who was especially struck by the idea, put forward by Buch, that Russian and English geological formations were very similar. In 1840 and 1841 Murchison went to Russia himself and published the results of his investigations in a work of 1845. This dealt with the geology of European Russia and the Urals and began to formulate the new Permian system. Murchison divided off three palaeozoic groups - the Silurian, Devonian and Permian. This book had a deep influence on Russian geology. According to Helmerson, Murchison was to geologists and palaeontologists what

Pallas had been to zoologists and botanists: a beacon throwing light on new scientific problems, concepts and methods.(52) The Academy of Sciences recognised Murchison's services and elected him as their first non-resident member.

Although there had always existed a sympathy for uniformitarian ideas and although the vulcanist theory was known in Russia, Lyell's Principles of Geology, which came out in England in 1830-33, was not published in Russia until the 1860s. Nevertheless in 1842 Dmitri Sokolov, then editor of the Mining Journal and professor at the Mining Institute and St. Petersburg university, published A Manuel of Geognosy which showed a full acquaintance with Lyell's theories.(53) It is possible that Murchison introduced Lyell's theory to Russian geologists when he visited Russia in 1841, since Sokolov, in a much longer work Textbook of Geognosy published in 1839, made no mention of then being aware of Lyell's ideas.(54) Roullier himself, whose ideas on development have been discussed in some detail in relation to transformism, was more sympathetic to a uniformitarian view point that to the catastrophic one.

Prior to 1859 the theoretical tendencies in Russian geology reflected fairly fully the various trends and conflicting ideas present in western European geology. It was a different situation to that that which existed in biology where the dominant trend was to transformism. However there were still certain similarities in the two sciences of significance for the reception of Darwinian ideas. The main theoretical tendency in geology was, if anything, towards uniformitarianism, though this was in no way such a well-defined or articulate trend as that of transformism in biology. Despite the links with Germany, Neptunism never established strong roots, and there was no eminent supporter of the catastrophic theory.

It is impossible to finish this discussion on theoretical scientific ideas in Russian biology and geology without also mentioning the philosophical trends present at that time in Russian thought.

German naturphilosophie has been referred to several times before and it did have a certain impact on Russian philosophy and science. Basically this was a philosophy searching for the unity of nature. It believed in the identity of nature and spirit: the Mind of Man and the Mind of Nature were two different sides of the universal or absolute Mind. It saw an underlying unity of all organic and inorganic phenomena. In science naturphilosophie based itself on observation and experiment, but at the same time it searched for a principle to unite the whole of the cosmos, to unite all of its opposing forces into an organised system. In Russia a number of scientists, for example Maksimovich of Moscow university, and Pavel Gorianinov of St. Petersburg university, were followers of Oken and developed theories based on the unity of movement and development in nature. Von Baer, too, was to some extent influenced by naturphilosophie when he was working in Germany and this may have first caused him to adopt a transformist position.

One important contribution of naturphilosophie to Russian science was that it showed scientists the need for general theories as well as for the collection of facts.(55) The next intellectual generation of the 1840s retained this feeling although they were more influenced by the ideas of Hegel than those of Oken or Schelling. Herzen, a representative of this generation stressed that philosophy and science were complementary.(56) By this he meant that empiricism would lead nowhere unless it was accompanied by speculation.

A scientist, whose ideas were close to those of Herzen's and his generation, was Roullier. Among these Russian intellectuals the Hegelian philosophy promised the possibility of social development and change. In biology Roullier taught his transformist ideas of development and change in the organic world. Herzen drew the parallel for society:-

> ". . . mankind has not given a written promise to live always as it is now; nothing is sacred to developing life. I know that the structures of the historical world are just as natural as the structures of the physical world . . ."(57)

Both Roullier and Herzen were also followers of the Baconian tradition believing "that the only source of scientific knowledge is experiment guided by the closest induction . . ."(58)

Both the generation under the influence of naturphilosophie and that under the influence of Hegel felt that the purpose of science was to find the general laws that governed nature. The former were prepared to allow vital forces and ideas to play as important a part as facts and observations. The latter rejected such methods relying on the close complementary roles of experiment and theory.

Both these philosophies were also relevant to the concept of evolution, in the sense that they prepared an intellectual climate sympathetic to the philosophical ideas posed by evolution, ideas such as development, progress and change. The concept of the unity of nature held by naturphilosophie was a philosophical basis for the transformist ideas of Oken, Goethe and Saint Hilaire and helped develop the idea of affinity between organisms. The Hegelian philosophy was interpreted by the Russians to mean development and progress. Although these philosophical ideas necessary for the concept of evolution were present in Russia prior to 1859, they were by no means the dominant ideas of the society. The autocracy stood for the very opposite conception of the fixity of the social order and in fact at one time Nicolas I forbade the use of the word progress.(59) Despite this fact the ideas of progress and change were held by leading and respected members of the intelligentsia who had a large influence on the generations of the 1850s and 1860s.

In the fields of biology and geology it is difficult to ascertain from where or why the tendencies to transformism and uniformitarianism originated.

The work of the three great embryologists was certainly sympathetic to it. The ideas of Buffon, Lamarck and Geoffroy Saint Hilaire were well known, but then so were those of Linnaeus and Cuvier. Perhaps the most important factor which influenced the Russian biologists and geologists to come down on the side of the former rather than the latter, was the vast Russian Empire itself. This provided a clear picture of the variations in species existing in different climatic and territorial regions and made it difficult to believe that each separate species under separate conditions was an individual act of creation. It also gave the Russian scientists an idea that the possible agent of change could be the influence of the changing surrounding conditions. In any case, this tendency to transformism, together with the lack of any leading catastrophist or supporter of the idea of the fixity of the species, meant that from the very start Russian biology and geology provided a receptive and sympathetic soil for Darwin's ideas on evolution. An illustration of this fact is the role played by the ideas of Roullier, ideas that have been mentioned in some detail previously.

Roullier was a dominant figure in Russian science in the two decades prior to 1859 and he was also close to the philosophical ideas of Herzen. He may not have been so well known internationally as Von Baer, Middendorff and other members of the Academy of Sciences, but it was Roullier who was in touch with Russian students and the future generation of biologists and geologists. One of his pupils, Y.A.Borzenkov, a comparative anatomist, commented on the influence of Roullier's transformist ideas in the following way at a ceremonial meeting of Moscow university in 1881:-

> ". . . together we [Borzenkov and a fellow pupil Usov] read Darwin's book which had arrived in Moscow (in the German translation by Bronn) when our conversations with Roullier were still fresh in our minds. This book was not the same thing that we had heard from Roullier, but something so closely related to what Karl Frantsovich had taught us that the new teaching seemed familiar from long ago, only now presented with great clarity and in a much more scientific form . . ."(60)

CHAPTER IV

The Dissemination of Darwinian Ideas.

When Darwin's theory of evolution was disseminated in Russia there were a number of factors that affected its reception; they influenced the speed of acceptance or rejection and shaped the character of that acceptance or rejection. These factors, however, were not necessarily decisive for the acceptance or rejection of Darwinian concepts as such. There has always been confusion over these two ideas. An acceptance of the theory of evolution simply involved an acceptance of the idea that species were mutable and had evolved in the course of time. An acceptance of Darwinism, on the other hand, involved belief in natural selection as the primary agent for the evolution of the species. Since these two concepts were not the same thing, those factors providing a generally favourable position for the reception of the theory of evolution were not necessarily favourable to the reception and assimilation of specific Darwinian concepts. Factors helping to define Russian attitudes to Darwinian concepts were generally peculiar to Russian cultural traditions and mores, and they had their own impact on Darwinism causing particular emphases and interpretations to be given to various of his concepts. Such scientific and public attitudes will be discussed in chapters 6 and 7. First the actual dissemination of Darwin's ideas in Russia and their reception and acceptance will be dealt with in more detail.

Darwin's theory of evolution contained in the Origin of Species reached Russia and became widely known there during the first half of the 1860s, this was a period significant for the reception of the theory in Russia in a number of ways.

Scientifically the position was very favourable, with the large expansion of the natural sciences and enthusiasm for them. Although the field in which Russians were most internationally distinguished at this time was chemistry, with scientists like Zinin, Butlerov and the younger Mendeleev; in biology the students, studying at the universities in the late 1850s and early 1860s, later became internationally respected scientists, men such as the Kovalevsky brothers, Sechenov, Mechnikov and Timiriazev. This young generation of future eminent biologists were able to accept the new theory enthusiastically and it was a symbol of their own progressive spirit. Russian scientists like many scientists in Europe and North America, believed in the progressive nature of their work, a belief that arose from the general progress of science at that moment and from the widespread conviction that its continuous development, beneficial to mankind, was in being.

The student biologists were further encouraged in their acceptance of evolution by the fact that there were no grand old men of Russian science openly opposed to the theory, either from the catastrophic point of view or from one of support for the immutability of the species. In Russia there was no Agassiz or Owen to polarize the elements of opposition to the theory of evolution. Moreover the tradition of transformism that already existed in Russian biology offered a fertile soil for the reception of Darwin's ideas.(1) It is also important to note that this tradition of transformism had not been built up round the ideas of one man. In France it was felt that Darwin's theory was rather unnecessary since it had all been said before quite adequately by Lamarck. In Russia there was no such one great man representing evolutionary ideas prior to Darwin.

Transformist ideas had been culled from various sources and Darwin's theory, when it came, was as equally acceptable as that of any other scientist.

In the cultural field the factors pertinent to the reception of the theory of evolution in Russia were perhaps of a more complex and peculiarly Russian nature.

Firstly there was the fact that the year 1860 was in the middle of a period of political reform. Although the Russian autocracy had never regarded the exact and natural sciences with such suspicion as the social sciences, they nevertheless retained a healthy suspicion of scientific concepts which could in anyway be regarded as revolutionary. Darwin's theory with its implications of progress and change would have had difficulty in obtaining a wide circulation in periods of political reaction such as had taken place between 1848 and 1855.

Closely associated with the political factor was that of the ambivalent attitude of the Russians to western Europe. The debate between the slavophiles and westerners, between those who felt that Russia had a unique destiny of her own and those who felt that she was subject to the same laws of development as the rest of Europe, has already been discussed. The 1860s was generally a period of receptivity to western knowledge and ideas, although, at the same time, it was a period of tremendous creativity in the arts and sciences accompanied by a marked national consciousness of Russia's own cultural contribution. During NicolasI's reign (1825-55) the autocracy had followed a policy of nationalism and self reliance, in an attempt to isolate Russia from the revolutionary ferment going on in western Europe. This policy, however, had led to the ignominious defeat of Russia in the Crimean war. Military strategy, weapons, transport were all out of date. It was obvious that Russia could not afford to isolate herself from western knowledge and techniques if she was to remain a great European power.

This receptive attitude to western European ideas, especially in the field of science and technology, and the climate of political reform were partially interdependent; taken together they were of prime importance for a quick acceptance of the theory of evolution since they ensured a sympathetic public mood and the possibility of widespread dissemination without severe censorship.

In fact the atmosphere of political reform resulted in a tremendous increase of literary activity and a large number of popular reviews were started at this time, many of them lasting till the end of the century. This increased freedom of expression was used by scientists and non-scientists alike to popularise the sciences, and for the first time in Russian history scientific theories became the subject of general discussion among educated circles. Darwin's theory was prominent among these, and its public reception was naturally influenced by the attitudes adopted towards it of those with intellectual authority in the society: scientists, writers, public administrators. In the 1860s this attitude was primarily favourable.

The popularisation of the sciences was combined with a belief in science as a progressive force. This meant that Darwinism, as well as being a symbol of the latest scientific thought, became also a symbol of progress in social thought. It acquired political connotations. This was not unnatural since the theory of evolution supported the concepts of both change and progress in the organic world and it was a short step to apply this to the social world. However, it did mean that although initially in the period of political reform Darwin's theory was not banned or persecuted in anyway by the authorities, later when autocratic policies became more firm and less liberal, Darwinism was seen as a theory with possible dangerous political connotations.

The other important cultural factor of the 1860s influencing the reception of the theory of evolution in Russia was the position of the church. The intellectual influence of the Orthodox church had been closely identified with the state autocracy for over a hundred years, and the policies of social and political reform pursued by the autocracy in the early 1860s meant that the church publicly tended to adopt such attitudes as well. Coupled with this factor was the more general one, independent of the period of the 1860s, that the church took little interest or lead in secular intellectual discussions.

The scientific and cultural factors outlined above, which belonged to the period of the 1860s when Darwin's theory was first being disseminated in Russia, provided a favourable soil for its reception and had a decisive influence on the speed with which the theory was accepted.

There were a number of ways by which Russian scientists and the Russian public learnt of Darwin's theory and ideas.

Firstly there was a direct contact with Darwin's writings. It is unlikely that many Russians saw the English version of the Origin of Species first published in 1859. However, the German translation by Bronn was well known in Russia.(2) The first Russian translation of the Origin of Species appeared in 1864,(3) prepared by the professor of botany at Moscow university, S.A.Rachinsky. There are varying accounts of its quality: Timiriazev found it an excellent translation on the whole,(4) but according to Pisarev it was extremely unsatisfactory. He said that the translation was highly inaccurate, that there were a large number of typographical errors, that there were no notes of comments from the translator on the contents of the book to help the general reader, and that, to crown it all, the errata at the back of the book were the wrong ones - they belonged to some other book.(5) These two contrasting opinions may both be partially true from the two respective view points of the professional scientist and the layman.(6) Although I have found no other direct comment on this first translation of the Origin of Species, there are several general references to the inaccuracy of translations made in the 19th century.(7) Despite this fact, the Russian translations of Darwin's works must have helped to acquaint the Russian public with his ideas. In 1867 Darwin wrote to Lyell:-

> "p.s. - A Russian who is translating my new book into Russian has been here, and says you are immensely read in Russian, and many editions - how many I forget. Six editions of Buckle and four editions of the Origin."(8)

The Russian referred to in Darwin's letter was Vladimir Kovalevsky, the palaeontologist and brother of Alexander. He translated Darwin's work The Variation of Plants and Animals under Domestication, which appeared in Russian in 1868 edited by I.M.Sechenov and A.Gerd.(9) The work was originally published as part of the definitive full scale treatment of the Origin of Species which Darwin promised all his life but never completed. On the back cover the editors acknowledge the kind cooperation that Darwin had shown them by sending the publishers the proofs of the work before it had even appeared in print in England, together with copies of all the illustrations. This meant that the first part of the Russian version appeared even earlier than the English edition and that its final part appeared simultaneously. It was printed in parts by the editors because of the large public interest:-

> "Knowing the lively interest shown to every work coming from the pen of Darwin, the publishers decided not to limit the number of sheets and to produce frequent instalments depending on when they received the proofs from the author."(10)

Thus during the 1860s Darwin's original works had been made available in Russian to the scientists and the public. In addition a certain personal contact had been established between the scientific community and Darwin himself.

In addition to the dissemination of Darwin's ideas in their original form, there were popular articles written by Russian scientists and writers, a number of which appeared prior to and around the time of the publication of the Russian translation of the <u>Origin of Species</u> in 1864.

In 1860 Professor S.S.Kutorga, who held the chair of zoology at St. Petersburg university began the academic year by reading his students a series of lectures on Darwin's theory. This is the first public reference to that theory known to have been made in Russia, and it is interesting that it was a scientist of the older generation who first acquainted Russian students with the new theory:-

> " . . . Kutorga, a year before his death and already doddery, was in all likelihood the first Russian professor to expound with his usual clarity, the contents of Darwin's Origin of Species, which had taken aback the whole scientific world. The book came out in November 1859 and already in September 1860, in one of the introductory lectures of the general zoology course, i.e. in the shortest possible lapse of time, - he acquainted the first year students with this revolutionary theory . . ."(11)

Professor Kutorga must have been aware of Darwin's ideas either directly through the English or German editions of the Origin of Species or indirectly through articles in foreign scientific reviews, of which most of the leading European ones were available in Russia in the libraries of the scientific societies and universities. It can be presumed that knowledge of Darwin's ideas was available to most Russian scientists working in Moscow or St. Petersburg through these channels from an early date. Nevertheless the majority of them did not feel the need to rush into print or polemic.

This supposition is further substantiated by the fact that in December 1860 the Herald of the Natural Sciences, a popular science review, published by the Moscow Society of Naturalists, printed two articles: one was a translation of Huxley's review of the Origin of Species, which had first appeared in the Westminster Review;(12) the second was the report of a paper presented to the Moscow Society by H.A.Trautschold called 'Transition and Intermediate Varieties'. Hermann Trautschold was a German geologist who worked and lived in Russia from 1857 to 1888. In his paper he stated that his studies confirmed Darwin's theory of the origin and evolution of the species.(13) Huxley's review was, of course, one favourable to Darwin's ideas.

A year later two long anonymous articles appeared in the review, The Reading Library, entitled 'Darwin and his Theory on the Formation of Species.'(14) M.A.Antonovich, a contemporary publicist and critic, wrote that their style pointed to Professor S.S.Kutorga as being the author.(15) It seems to be generally accepted that he was in fact the author though no reason has been given for his remaining anonymous. Anonymous articles and pseudonyms were quite common in 19th century Russia because of the censorship and possible political suppression, but 1861 was in the middle of a period of reform and intellectual activity and, since no other articles on Darwinism went unsigned at this time, it seems unlikely that Kutorga remained anonymous for political reasons. In his articles Kutorga gave a short description of the main theses of Darwin's book. He did not totally accept Darwin's theory but described it as the most logical and satisfactory one formulated so far, and regarded it as a tremendous contribution towards finding a solution for the problem of the species.

In 1862 the review Time carried an article on the Origin of Species entitled 'Evil Portents'(16) by the critic and former scientist N.N.Strakhov, who later took up arms against Darwinism in the only real public polemic to centre round that theory in Russia. In his article, which was quite short, Strakhov, like Kutorga, welcomed Darwin's contribution as a very important first step to the solution of the problem of the species, though, unlike Kutorga, he gave little exposition of the contents of the Origin of Species. His article was in the style of a critique and he must have assumed that his readers knew, however roughly, the outlines of Darwin's book. The title 'Evil Portents' was a reference to the attempt by the French translator of the Origin of Species, Clemente Roye, to justify the capitalist system on the basis of Darwin's ideas of the struggle for survival and natural selection. Strakhov felt very strongly that the methods of the natural sciences were inapplicable to the problems of society.

The same journal Time was sent a review of the Origin of Species by the eighteen year old student, Ilya Mechnikov, the following year.(17) This again was a critique rather than a popular exposition; it was never published and only exists in manuscript form.

In January 1863 Professor Rachinsky, the translator of the Origin of Species wrote an article entitled 'Flowers and Insects',(18) which was primarily based on Darwin's work On the various contrivances by which British and foreign orchids are fertilised by insects and on the good effects of intercrossing. The main body of the article was a popular exposition of the theory of natural selection using the interrelationship of orchids and insects as an illustration of it. In this part Darwin was only referred to in passing. However, at the end of the piece Rachinsky had this to say:-

> "Just two years ago, in one of the most brilliant books ever written on the natural sciences, Charles Darwin expounded a number of observations and facts, which seemed to completely prove and explain the hereditary relationship between organic beings and their amazing adaptation, one to the other and to the organic world. I say seemed because Darwin has not yet published all the factual material upon which his view is based . . . But nevertheless one can firmly say that in the branch of science dealing with organisms such a carefully thought out and subtly developed theory has never been expounded before, a theory which explains all the known phenomena so completely and harmoniously."(19)

Rachinsky followed this with a very brief summary of Darwin's theory and wrote in a footnote that he hoped his article would stimulate the reader to acquaint himself with the contents of the Origin of Species itself.

The following year his translation appeared, and in addition a number of popular accounts of Darwin's theory were published; including one by K.A.Timiriazev called 'Darwin's Book, Criticisms and Commentators' which appeared in the review Notes of the Fatherland,(20) and another by Dmitri Pisarev entitled 'Progress in the Animal and Plant Worlds', was published in the review Russian Word.[21]

K.A.Timiriazev was one of the most energetic champions of Darwinism in Russia, playing in that country much the same role that Huxley played in England and Asa Gray in America. He had the advantage of being able to speak, read and write English fluently, a language which he was taught by his mother when a child. In 1864, although only twenty one years old and still a student on the Physical-Mathematical Faculty of St. Petersburg University, he wrote his highly detailed and careful review of the ideas expressed in the Origin of Species. He was generally in complete agreement with Darwin and the article was a summary of the basic precepts of natural selection using many quotations from the Origin of Species.[22]

The contents of the first two parts, which posed the problem of the origin of organic beings, can be best summed up in Timiriazev's own words:-

> "We saw that the general facts of the classification of organic beings, of embryology, and of geology favour the proposition that organic beings arose by

means of variation. Then we saw that the only obstacle preventing the acceptance of that proposition was the belief in the fixity of organic forms, in the immutability of the species. We used all our strength to shake and overthrow this belief and completely succeeded in doing so: the example of the different breeds of pigeon showed us how deeply species can vary; the critical appraisal of the concept of a species and a variety showed us the impossibility of erecting a border between them and led us to the conclusion that a variety is a species in embryonic form . . .
"And thus organic forms do vary; all of nature is in a state of continual flux; consequently the chief obstacle to accepting the unity of the origin of all organic beings is removed. But that is still very little. It is now necessary to sketch out the very process of variation, a process which would agree with all the known facts, which would remove all apparent contradictions such as, for example, the lack of transitional forms etc., and which would explain the chief and most puzzling fact - the striking perfection of organic forms . . ."(23)

In the next three parts of his article Timiriazev dealt, as he said he would, with the actual process of variation of the species, keeping fairly close to the text of the Origin of Species. First he discussed artificial selection taking in most of the points contained in

Chapter I of the <u>Origin</u>. He concluded that the chief method by which animal breeders and horticulturists achieved their aims was the unconscious or conscious selection of small insignificant variations which, when accumulated over several generations, formed significant varieties and that this process of selection of favoured organisms necessitated the extinction of the less favoured.[24]

Next he dealt with the struggle for existence and natural selection using many quotations and examples from Chapters III and IV of the <u>Origin</u>, including Darwin's reference to the fact that "In Russia the small Asiatic cockroach has everywhere driven before it its great congener,"[25] a fact of direct relevance for Timiriazev's readers. He concluded that:-

> ". . . this process, natural selection, completely explains the most important and mysterious fact that strikes everyone looking at the organic world, namely its amazing perfection and harmony . . ."[26]

In this part of the discussion Timiriazev made an interesting comment on the Russian translation of the word 'selection'.[27] Professor Rachinsky in his translation of the Origin of Species had primarily used the word 'podbor', which according to Timiriasev was equivalent to the English word 'match',* with its overtones of an aim to achieve some specific ideal or image. In his article Timiriasev had used instead the Russian word 'otbor' which more truly corresponded to Darwin's use of the word 'selection' with the meaning of isolating or separating things in some way differing one from another but without the overtones of a qualitative judgement. Although 'otbor' is generally used now, it was not accepted immediately then.(28) In another footnote further on in the discussion, Timiriasev commented that the misinterpretation of the word 'selection' to imply that nature exercised some sort of will in the process had been quite common outside Russia as well, and Darwin had had to explain in later editions that he only used the word in a metaphorical sense.(29)

In the final part of his article Timiriasev discussed a number of points such as divergence and extinction,

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*Timiriasev gives this equivalent, but I think the closest modern word would be 'to select' in the sense of 'choose' or 'pick'.

transitional forms, the long time scale necessary for evolution by natural selection and the evidence of the geographical record. He concluded by quoting the last paragraph of the Origin:-

> "It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us. These laws, taken in the largest sense, being Growth with Reproduction; Inheritance which is almost implied by reproduction; Variability from the indirect and direct action of the conditions of life and from use and disuse; a Ratio of increase as high as to lead to a struggle for Life, and as a consequence to Natural Selection, entailing Divergence of Character and the Extinction of less-improved forms. Thus, from the war of nature, from famine and death, the most exalted object which we are capable of conceiving, namely, the production of the higher animals directly follows. There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this plant planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."(30)

This article was reprinted the following year, 1865, in book form under the title A Brief Account of Darwin's Theory. It was reissued in 1882 in a collection of essays entitled Charles Darwin and His Teaching,(31) in which form it went through two more editions in the 19th century, one in 1894 and one in 1898. In the introduction to the 1894 edition Timiriazev likened it in its scope to similar collections issued in other countries under the name Darwiniana.(32) The content of these later editions did not differ essentially from that of the 1864 article. Parts were extended to give more up-to-date examples, but the thesis remained the same.

The other popular account of Darwin's theory published in 1864, 'Progress in the Animal and Vegetable Worlds' by Dmitri Pisarev, was a long popular exposition of the ideas and arguments contained in the Origin of Species. Pisarev, who was a radical intellectual, believing in the progressive nature of the natural sciences, but not a natural scientist himself, thought that Darwin's theory was a tremendous achievement. He also felt that Russian scientists or review editors had little respect for the Russian public, who, not having participated in scientific discussions before, were now being given theoretical scientific works and articles to read with little explanation or help, the Russian translation of the Origin of Species being a case in point. His criticisms of this have already been mentioned but it was because of the failure, as he considered it, of the translator to help the reader to understand unfamiliar scientific terms and concepts, that Pisarev decided to write his own article.(33) Besides a popular exposition of the concepts of evolution and natural selection as contained in the Origin of Species Pisarev also drew heavily from the ideas of Karl Vögt and introduced certain of his own emphases into the discussion, emphases which he said Darwin had pushed into the background:(34) for example the influence of rearing and circumstances of life on organisms and the contribution of conscious efforts on the part of the organism to progress.(35) These emphases were of a more political or social than scientific nature.

Thus we find that in the first five years after the publication of the Origin of Species at least six serious accounts or critiques of the theory by Russians had appeared in print in a fairly wide range of contemporary reviews acquainting the public with the ideas of the new theory.(36) The Russian public, however, did not have to rely only upon their own writers and scientists for information about the Origin of Species. Prior to the Russian translation in 1864, one foreign review was printed in Russian translation, namely Huxley's which had first appeared in the Westminster Review.

In 1865, very soon after its first publication, a young student natural scientist, Nozhin, translated into Russian the work Facts and Arguments for Darwin(37) by Fritz Müller, a German scientist who lived in Brazil for many years. In the preface to this book Müller described his aim in the following way:-

> "It is not the purpose of the following pages to discuss once more the arguments adduced for and against Darwin's theory of the origin of species, or to weigh them one against the other. Their object is simply to indicate a few facts favourable to this theory, collected upon the same South American ground, on which, as Darwin tells us, the idea first occurred to him of devoting his attention to 'the origin of species - that mystery of mysteries'. It is only by the accumulation of new and valuable material that the controversy will gradually be brought into a state fit for final decision, and this appears to be for the present of more importance than a repeated analysis of

what is already before us. Moreover, it is but fair to leave it to Darwin himself at first to beat off the attacks of his opponents from the splendid structure which he has raised with such a master-hand."(38)

The new material that Fritz Muller introduced derived from the study of Crustacea. He had set out to test Darwin's theory by applying it to this particular group of animals and by attempting to build a "Geneological tree of the Crustacea". However, he had found that this would take many years of research and so instead he decided to publish those arguments, derived from his consideration of the Crustacea, which favoured Darwin's views and which helped make their truth essentially more palatable. Also published in 1865 was a translation of the German geologist Dr. F. Rolle's Darwin' Teaching concerning the Origin of Species, a popular exposition,(39) in which he set out his belief that man was descended from some lower form of animal.(40)

There were, of course, many other foreign discussions on the Origin of Species available to the Russian public in their original language if not in Russian. For example Pisarev refered to Professor Karl Vögt's

Lectures on Man(41) published in 1863, in which Vôgt stated that prior to Darwin he had been opposed to transmutation theories, but that he found Darwin's theory a real advance towards the knowledge of truth and on that basis he accepted that transformation, adaptation and natural selection were processes present in nature.

In addition to direct accounts of Darwin's theory, either written in Russian or translated, there were several books and articles on general subjects that contained references to the theory, which must have helped to make the public aware of it in the early 1860s. For example Ilya Mechnikov in his unpublished review written in 1863 quotes Ivan Levakovsky, of the Kharkov University Geology Department, as saying in his book A Course of Geology:-

> "In the final analysis we conclude that science has not yet produced a sufficient amount of facts either for the confirmation or refutation of Darwin's theory, which itself at nearly every step turns to the negative argument - the lack of research."(42)

Levakovsky's A Course of Geology was published between 1861 and 1864 and this quotation from it again confirms the supposition that Russian scientists did not have to and did not wait for the Russian translation of the Origin of Species in order to acquaint themselves with the contents of this book.

Another example of general articles containing references to Darwin's theory was one by the French naturalist Quatrefages[(43)] entitled 'The Natural History of Man', which appeared in the Russian Herald in 1861 and which mentioned Darwin's book in passing:-

> ". . . in the work of the English naturalist Mr. Darwin, which appeared not very long ago and which is remarkable in many respects, Darwin tries to explain the origin of the multitude of animal and plant species. He produces them all from one primary form, which, as a result of the outside influences and conditions of existence, undergoes successive changes of species and organisation in a thousand ways; Darwin apparently connects these changes primarily with geological phenomena. Thus Darwin merges together in his theory the ideas of Lamarck on the mutability of species and the ideas of Buffon on the causes of these variations; together with this he gives such applications of his theory that remind one of the teaching of Geoffroy. However in both these and other points, the English naturalist has gone further than his French predecessors."[(44)]

Quatrefages did not spend much time on this remarkable book, as he called it, but he did have time to point out that many of Darwin's ideas on species had been developed by Quatrefages himself with respect to breeds in a lecture he had given in 1846, and that Darwin's whole theory had been formulated by a Frenchman, M.Naudin, in 1852 and 1858. Having cast these aspersions, Quatrefages hastily added that he had no doubt of the worth and honesty of "M. Darwin."

The main theme of Quatrefage's article was 'The Unity of the Human Race'. In this and in another article he wrote on the same subject published in 1864 in the review Russian Word, Quatrefages maintained that the different human races were one unity, or one species. His 1864 article was reviewed later that year in the same journal by a writer and polemicist Zaitsev.(45) Zaitsev criticised Quatrefages and put forward the hypothesis of the inequality of human races which he said he had deduced from the ideas of Darwin and Vögt. This review raised a storm and throughout 1865 articles appeared in a number of reviews linking Zaitsev's name with support for the slavery of the black races.(46) Darwin's theory was used by both sides in this argument, both to prove the essential unity of the human races and to prove the existence of specific differences between the races. This type of general discussion with reference to Darwin's theory helped to bring the latter to the notice of the public.

These articles written prior to and around the time of the publication of the Russian version of the Origin of Species were introductory articles to Darwin's theory. They helped to disseminate his ideas and, since they were generally very favourable, they encouraged their public acceptance. The theory of evolution was one of the first, if not the first, scientific theory to be widely written about and publicly discussed in Russia. The public had little basis for rejecting it since it was openly supported by the majority, if not all, of the authoritative scientists. K.A.Timiryazev's article, 'Darwin's Book, its Critics and Commentators', is a good example of how the Origin of Species was being presented to the public. And, as already explained, non-scientific prejudice was less in Russia than elsewhere.

This favourable climate of opinion can be further confirmed by a brief analysis of the contents of two of the more important conservative Russian monthly reviews which, from what happened in other countries, could have been expected to be the most likely to be hostile.[47] The review _Russian Herald_, whose editor, Katkov, was a very influential liberal conservative, was said by the contemporary critic, Antonovich, to have at first ignored Darwin's book and theory and then, when it saw that the theory had triumphed, to have printed translations of the strongest attacks made on the theory in England.[48] The facts do not uphold this accusation for the period of the 1860s. In addition to Rachinsky's very favourable comments on and illustrations of Darwin's theory in 1863, the other three articles which appeared between 1866 and 1869 containing references to Darwin's ideas could hardly be described as extremely hostile.

The first appearing in 1866 was again by Rachinsky, this time a review of Kaufman's _Moscow Flora_. In his review Rachinsky dealt specifically with systematics and in relation to this field he welcomed Darwin's book since "it had blown new life into systematics, proposing at one and the same time an explanation of both the relative fixity and the absolute mutability of the species . . ."[49]

Later that same year, in September 1866, a report was published in the _Russian Herald_ of that year's meeting of the British Association for the Advancement of Science.

This article, after a short account of the Association's history, gave a fairly full report of the opening address by the President, William Grove.(50) After surveying all the other fields of science, Grove concluded with a discussion of modern trends in biology and geology, including the question of the fixity or transmutation of the species. In putting forward the arguments around this question Grove generally came down in favour of transmutation:-

> "I have of course been able to indicate only a few of the broad arguments on this most interesting subject . . . If I appear to lean to the view that the successive changes in organic beings do not take place by sudden leaps, it is, I believe, from no want of impartial feeling; but if the facts are stronger in favour of one theory than another, it would appear to be an affectation of impartiality to make the balance appear equiposed."(51)

Most of his arguments in favour of transmutation were not printed in the Russian Herald; instead was quoted a passage in which Grove considered the arguments against it:-

> "The doctrine of gradual succession is hardly yet formularised, and though there are some high authorities for certain modifications of such view, the preponderance of authority would necessarily be on the other side."(52)

However, the article in the Russian Herald did quote in full Grove's concluding remarks where he applied the theory of continuity in the physical world to society, saying that the gradual evolution of society was more sound and led to better results than a priori principles of revolution and the rights of man, a viewpoint which was close to that of Katkov, the editor of the Russian Herald. Despite the fact that this article was at no pains to encourage Darwin's theory it can hardly be regarded as a hostile attack. And two years later a report of the 1868 British Association meeting was published which quoted excerpts from Joseph Hooker's presidential speech where he stated that, after ten years, Darwin's theory of natural selection was acknowledged by most scientists to be an important hypothesis even if they did not give it quite the same emphasis as Darwin.(53)

Thus during the 1860s the Russian Herald was certainly not hostile to Darwin's theory, though, it can also be said, that it was not positively enthusiastic either.

A similar situation occurred in The Orthodox Review, one of the most lively and influential ecclesiastical reviews of the 1860s.(54) In its index for the years 1860 to 1870(55) there is no reference to Darwin, evolution, the origin of species or to any of the Russian or foreign scientists supporting or opposing the theory of evolution. They did print early in 1860 an article on the origin of the human species which supported the catastrophic viewpoint but this appeared before Darwin's theory was generally known in Russia and made no reference to it itself. Apart from that there were two articles, with only oblique references to Darwinism, which commented on the relation between scientists and religious faith.

The existence of a climate of opinion in Russian society favourable for the reception of Darwin's ideas can be illustrated by the lack of hostility in these two predominantly conservative and religious reviews and is further confirmed by the situation within the official scientific organisations.

The fact that the Imperial Academy of Sciences was regarded as more Imperial than Scientific has already been mentioned,(56) and in the Russian context where Darwinism was a symbol of progress, it was normal for radical Russian scientists to see the Academy as naturally anti-Darwinian. Timiryazev in his piece 'The Development of the Natural Sciences in Russia in 1860s' referred to Academician Brandt as "hacking at the very roots" of Darwinism.(57) Nozhin, a natural scientist who died very young in 1866, wrote a long article entitled 'Our Science and Scholars'. The last part of this, which appeared after Nozhin's death, was devoted to Darwin. In it Nozhin attacked the anti-Darwinists and named among them members of the Academy of Sciences:-

> "It is only our Academy of Sciences in the persons of Messrs. Von Baer, Brandt and several others which resolutely does not recognize Darwin's theory . . .
> ". . . this forces one automatically to suppose, however strange it may seem, that our academicians just simply did not understand the theory they had refuted, but had only instinctively guessed that they have to refute and deny every vital tendency in science."(58)

Despite these accusations, Darwin was elected a corresponding member of the biological section of the Imperial Academy of Sciences in 1867.

When a vacancy appeared at the end of 1867, the academicians F.I.Ruprecht (botanist), F.F.Brandt (zoologist), F.V.Ovsiannikov (physiologist), L.I.Schrenk (zoologist) and A.A.Strauch (zoologist) decided to put forward Darwin as a candidate. None of these naturalists is well-known as a champion of Darwinism in Russia and in fact Brandt was one of those accused by Nozhin and Timiryazev of being anti-Darwin. So it seems that both the official state and the official scientific attitude to the Origin of Species at this time was one of respect and not fear. In the note that the five academicians presented to the Dept. of Physical and Mathematical Sciences they said that Darwin was one of the most distinguished of contemporary naturalists. His first work on coral reefs had assured him that ranking. They went on to say:-

> " . . . But we rarely see a work on natural history so widely known or read with such interest as Darwin's book On the Origin of Species. It has already passed through four editions; and besides it has been translated into many languages making Darwin's ideas known to the whole of the educated world. The ideas that Darwin has developed in the Origin of Species are neither completely new nor unknown. However, he puts them forward with such authority supported by a large number of accurate observations and subtle generalisations, that they make up a connected whole, with which Darwin is able to bring influence to bear on the convictions of the reader."(59)

The note went on to say that as so much had been written, printed and argued about this book the authors thought it unnecessary to go into further details. They took note however that even those naturalists who do not share Darwin's views nevertheless do agree that he had achieved fame both by his enormous work on systematics and by the excellent facts he had put forward to support his own theory; these show the perspicacity of the author and his fortunate gift in their organisation and collation. Finally the academicians drew attention to Darwin's humility and equanimity especially when under hostile attack from his critics. In their own view the academicians thought that Darwin's work was as important for systematics as that work done by Goethe and others on the metamorphosis of plants had been for plant morphology. They finally listed the works produced by Darwin since the Origin of Species, concluding that using his method Darwin was able to throw new light on old and well-known material.(60)

The elections to the Department of Physical and Mathematical Sciences of the Imperial Academy took place on November 28th, 1867. There were fifteen votes cast for Darwin and three against. As it was a secret ballot it is impossible to know how each individual voted. The results were announced at a general meeting on December 1st, 1867, and then again at the annual ceremonial meeting of the Academy on December 29th, 1867. Preserved in the archives of the Academy is the following note of acknowledgement and thanks from Darwin sent from Down on March 4th, 1868:-

> "Sir,
> I beg leave to acknowledge the receipt of your letter of January 3, in which you announce to me that the Imperial Academy of Sciences has done me the honour of electing me a corresponding member in the section of Biology. I assure you that I feel deeply sensible of this most distinguished honour.
> I beg leave to remain sir your most obedient servant.
> Charles Darwin."[61]

Two years after this letter was written Darwin's work was again formally recognised in Russia. In 1870 he was elected to Honorary Membership of the Moscow Society of Naturalists. Darwin's proposer for election was H.A.Trautschold, the German geologist who had read a paper to the Society in 1861 supporting Darwin's views.[62] Five of the people attending the meeting to elect Darwin in 1870 had been present at this 1861 reading. Darwin's seconder was K.I.Renard, the editor of the Society's review. At the same meeting T.H.Huxley and Thomas

Davidson[63] were elected as regular members of the Society. Darwin replied to the news of his election in the following letter sent from Down on May 28th 1870:-

"Sir,
I beg leave to thank you for your very courteous letter of May 20th in which you announced to me that the Imperial Society of Naturalists of Moscow has conferred on me the distinguished honour of electing me an Honorary Member. This morning I received your Diploma. I hope that you will express on my part to the Society how deeply I feel gratified by this honour. In accordance with your suggestion I have directed my publisher to forward to your Society the last edition of my Origin of Species and my Journal of Researches during the Voyage of the Beagle.
With my Sincere Thanks,
I have the honor to remain Sir,
Your most obedient Servant,
Charles Darwin."[64]

The formal recognition of Darwin by the Imperial Academy of Sciences in St. Petersburg and by the Moscow Society of Naturalists was fairly early in comparison with other countries. His work had of course been recognised in England prior to the publication of the Origin of Species. But apart from that, the only other national Academies besides the Russian to give him official recognition in the ten years after 1859 were the Royal Prussian Academy of Sciences in Berlin (1863), the Royal Swedish Academy of Sciences (1865) and the Royal Irish Academy (1866). In general the bulk of honours conferred on Darwin in recognition of his work on evolution were given in the 1870s.[(65)]

This review of the reception of Darwin's ideas in Russia, taking into consideration translations of the original Origin of Species, articles by scientists and popular writers, the attitudes of conservative and official organisations shows that in the 1860s attitudes were favourable to the theory of evolution and there was an official, scientific and public acceptance. The reasons for this favourable situation depended on the scientific and cultural factors already outlined above. However, these latter cultural-political factors were by no means stable, and, unlike scientific attitudes, official and public attitudes to Darwin fluctuated throughout the rest of the 19th century.

The demand of the reading public for the original works of Darwin during the last forty years of the nineteenth century is a case in point. Most of Darwin's important works written after 1859 were translated into Russian indicating that a public demand for his works can be assumed to have existed throughout the 1870s. _The Descent of Man and Selection in Relation to Sex_ was brought out in 1872, a year after the English edition, under the editorship of the physiologist Sechenov. _The Expression of the Emotions in Man and Animals_, edited by the embryologist A.O.Kovalevsky, also appeared in 1872, the same year as the English edition. Other works by Darwin which were translated into Russian were _A Naturalist's Voyage Round the World_ in 1871 edited by A.Beketov, _Insectivorous Plants_ in 1875, _The Power of Movement in Plants_ in 1880 and _The Formation of Vegetable Mould through the Action of Worms_ in 1881. By 1917 there had been eight editions of the _Origin of Species_, including its publication in editions of Darwin's collected works. The separate publications of various works of Darwin totalled 40 by 1917. The collected works were issued several times. Between 1898 and 1901 O.N.Popovoi brought out an edition edited by K.A. Timiryazev. For the 50th anniversary of the publication of the _Origin of Species_ and the 100th anniversary of Darwin's birth an _Illustrated Collected Works_ of Charles Darwin was published by Y.Lepkovsky. There was also another collected works published and translated by V.V.Bitner, but this was of a rather poor quality.(66)

In looking at this list of Russian translations of original works by Darwin, it is noticeable that there was a gap in the 1880s and early 1890s. Interest seems to have waned in this period. In 1894 Timiryazev commented that the Russian translation of the Origin of Species had become a bibliographic rarity probably because of a certain lessening of the reading public's interest in the natural sciences.(67) A few years later, however, the position seems to have changed radically. In 1898 Timiryazev commenting on what he had written in 1894 wrote:-

> "After a very short period of time . . . the picture changed significantly. Once again there is a big demand for serious scientific literature: the large edition of the new Russian translation of Darwin's works was sold out before its appearance (by subscription) and soon the second edition will be out. One can't help but be glad at the expansion of the circle of readers interested in the original works of the great scientist . . ."(68)

The lessening of interest in original works by Darwin in the 1880s was accompanied by a certain hostile public attitude, manifested most completely by the polemic which took place then between Timiryazev and N.N.Strakhov.[69] Timiryazev gave an interesting account of the change in public opinion that had taken place between the 1870s and 1880s in a lecture delivered in the Moscow Polytechnical Museum in 1887:-

> ". . . 'tell me, is it true that Darwinism has been refuted?' I remembered that less than ten years ago I had given a speech on a similar theme and before a similarly distinguished audience, and this made it clear to me that much has changed since then. At that time people only asked me to explain something here, to reconcile something there, to describe the most interesting details about the personality of that theory's author; now I shall have to enter into a struggle for survival. That, which then was almost unanimously acknowledged as one of man's greatest intellectual achievements, is now, according to hearsay, declared some sort of mental epidemic, some sort of pitiful herd enthusiasm. That, anyway, is the impression created by a certain section of our periodical press, by conversations and by scraps of opinions . . ."[70]

A lack of enthusiasm, if not open hostility, was also present in official science and perhaps is best illustrated by a comparison of the obituary notices on Darwin given by the Academy of Sciences and the VIIth Congress of Naturalists and Doctors respectively. The obituary notice issued by the Academy of Sciences was the first mention of Darwin to appear in its official records since his election as a corresponding member in 1867. It seems rather short and curt:-

> "Charles Darwin, one of the most gifted naturalists of our century, who gave a powerful impetus to the natural sciences, ended his glorious career on April 19th. Englishmen, who are always conscious of those who have added new glitter to the English name, have placed the ashes of the great reformer of modern science in the pantheon of their native glory, Westminster Abbey, next door to Newton, as though under the canopy of that inscription, which shines on the grave of the latter - Decus generis humani."(71)

At the VIIth Congress of Naturalists and Doctors held at Odessa in 1883, A.O.Kovalevsky gave a speech dedicated to Darwin in which he said:-

> ". . . at the beginning of 1882 our great teacher Darwin died, a man whose theory and name have now entered into all fields of science; Darwin's ideas have penetrated everywhere, attempts are made to explain all phenomena of individual and social life by his general laws. Darwin died far from having completed all his work; he died in a period when almost annually more and more new works appeared: the results of almost fifty years of unremitting scientific activity. Darwin's theory

> was received with special sympathy here in Russia. At that time when, in western Europe, it was meeting with firmly established old traditions which had first to be overcome, in Russia its appearance coincided with the awakening of society after the Crimean war, and it at once received the right of citizenship both in scientific and social circles, and up to this time it enjoys general sympathy."(72)

Although Kovalevsky said that Darwin's theory still enjoyed general sympathy, it is clear from the Academy of Sciences obituary notice as well as from the fact of the public polemic a few years later that the public atmosphere and attitudes if not the scientific were changing.

Timiriazev gave a number of instances of an official attitude hostile to Darwin's ideas. Students from the Petrovsky Agricultural Institute, who sent a telegram and wreath to Darwin's funeral in 1882, were regarded as dangerous revolutionaries.(73) Timiriazev himself was accused by Prince Meshchersky of chasing God out of nature[74] and was relieved of his post at the same Agricultural Institute in 1892, when it was closed down for a few years.[75] Timiriazev stated that a fellow botanist, Korshinsky, received 25,000 roubles for his research work as a reward for declaring himself an anti-Darwinist.[76] These instances of anti-Darwinian actions by the government are difficult to substantiate fully but they do illustrate Timiriazev's own interpretation of government attitudes. The 1883 Congress of Naturalists and Doctors accepted Kovalevsky's proposal that £20 of its funds should be contributed to a European fund for a memorial to Darwin,[77] and there is no mention of the government's disapproving of or forbidding this action. Perhaps any action of the students was automatically more politically suspect than that of the scientists since the former were considerably more politically involved and committed.

The political climate was one of reaction in this period right up to the end of the 19th century, and this did have its effect on scientific circles as well as on more politically active groups in society. Despite non-participation in politics, Mechnikov was considered 'red' because of his independent thinking, and the petty jealousies of the university world together with the hounding of the authorities eventually drove him in 1886 to exile in Paris in the Pasteur Institute, where he had conditions of freedom of work he had never experienced in Russia. In 1903, when his book Studies of Man's Nature, came out in Russia, the third chapter, entitled 'The Origin of Man from the Ape', had trouble with the censor. Professor N.A.Umov, who was the scientific director of the publishing firm in charge of Mechnikov's book, wrote to Mechnikov in Paris:-

> "Chapter III has been passed by the censor. In order to ensure this several changes were made in the text. As you will see they don't concern the essence of the matter. Thus in the title instead of 'The origin of man from the ape' we put 'The Hypothesis of the origin etc.' Instead of - blood relationship of man and apes - we put: the relationship of the blood of man and ape. Instead of saying that the origin of man is explained by religious dogma, we put by ancient beliefs.
>
> "I don't think you will have anything against these changes but will only be amazed that such trifles ensure the penetration of scientific truths to the public. I would ask you to allow me to make such changes . . ."(78)

The official attitude towards Darwin's theory was dependent on the political moods of reform or reaction of the government. The theory taught that species had evolved historically and this applied to society meant that political structures would change with time when they had outgrown their usefulness. In the 1860s the autocracy had not feared this idea since it was itself attempting to reform society. However by 1881, when it had been seen that the reforms of the 1860s, instead of leading to a stable political situation, had resulted in more and more extreme methods of political opposition culminating in the assassination of the Tsar, the autocracy feared that any change would lead to its own destruction, and it consequently feared the influence of such ideas as the theory of evolution.

The public attitude was influenced but not determined by official attitudes. Many of the educated Russian circles who made up the reading public were in some way opposed to the autocracy, did not identify themselves with it, and were supporters of some form of political reform. Their attitudes were perhaps more influenced by Russian national cultural traditions. The upsurge of pan-slavist feeling in the late 1870s and 1880s prepared the ground for the public attack launched on Darwinism by Strakhov. However by the end of the 1890s when the official attitude was still suspicious there was again a tremendous demand for works by Darwin and on Darwin.

CHAPTER V

Science in the Framework of the Theory of Evolution.

In 1859 to accept a theory of evolution of the species on a scientific basis it was necessary to have a satisfactory mechanism to explain how such a process could take place. As Darwin pointed out in the introduction to the first edition of the Origin of Species many of the facts already known to biologists and geologists could be accommodated as easily within an evolutionary theory as within a theory of special creation:-

> "In considering the origin of species, it is quite conceivable that naturalists, reflecting on the mutual affinities of organic beings, on their embryological relations, their geographical distribution, geological succession, and other such facts, might come to the conclusion that each species had not been independently created, but had descended, like varieties from other species."(1)

It was only the mechanism or means of evolution that was missing. The mechanism that Darwin proposed and which made his theory of evolution or the succession of the species tenable was natural selection, a concept fundamentally based on three ideas supplied by Lyell, Malthus and Darwin's own experience gained on his travels.

Darwin assumed that the number of individuals in any one species was continually increasing so that they consequently would come into competition with each other for the available means of survival. A struggle for existence resulted which meant that a certain number of the members of each species would be eliminated without having offspring. Since all the individuals of one generation of species varied in their characteristics it would be those with the variations favourable for their survival which would survive and reproduce; those with unfavourable characteristics would be destroyed. The offspring of the surviving members of the species would inherit the favourable features of their parents and so such features would tend to replace the unfavourable ones as the process continued. This process of natural selection acting on all the features of the variety over a long period of time could eventually give rise to a new species. Darwin characterised his theory in the following words:-

> "Owing to this struggle for life, any variations, however slight and from whatever cause proceeding, if it be in any degree profitable to an individual, of any species, in its infinitely complex relations to other organic beings and to external nature, will tend to the preservation of that individual,

> and will generally be inherited by its offspring. The offspring, also, will thus have a better chance of surviving, for, of the many individuals of any species which are periodically born, but a small number can survive. I have called this principle, by which each slight variation, if useful, is preserved, by the term Natural Selection, in order to mark its relation to man's power of selection."(2)

In the debate that followed the publication of the Origin of Species the two separate themes, evolution and natural selection, became inextricably confused in the public's eye; at the same time, although Darwin had based his argument for evolution on the theory of natural selection, some accepted the theory of evolution without necessarily accepting natural selection as its chief and most important agent.

For the scientist there were several possible attitudes to take. He could reject the possibility of evolution entirely and so the question of natural selection did not arise, or he could reject natural selection and for that reason the theory of evolution also. On the other hand the scientist could accept the theory of evolution and together with it the mechanism of natural selection, or, as happened in many cases, the theory of evolution was accepted but a critical attitude was adopted towards natural selection and a number of complementary hypotheses were put forward in an attempt to explain the agents of evolution.(3) For those scientists who accepted the theory of evolution immediately after 1859 their acceptance was still very much an act of faith, since the scientific facts were by no means all in favour of the theory and Darwin himself dedicated a large part of his book to pointing out the difficulties facing the theory and trying to refute them.(4)

In Russia, although reservations existed concerning natural selection, the concept of evolution of the species was never in doubt among scientists. As pointed out earlier a number of factors contributed to this situation.

The date of the publication of the <u>Origin of Species</u> coincided in Russia with a period of tremendous development and vitality in the sciences, especially chemistry and biology. Many future biologists and geologists were at university or even school. In an analysis of the ages in 1860 of thirty-three(5) leading biologists working in the two decades after the publication of the <u>Origin of Species</u> we find the following:-

Von Baer	in his sixties
Brandt	in his fifties
Trautschold, Kessler, Ruprecht	in their forties
Tsenkovsky, Beketov, Ovsiannikov, Severtsov	in their thirties
the remaining twenty two	in their twenties or younger.

Thus the overwhelming majority were young scientists just starting out on their careers when Darwin's book was published and they had no difficulty in accepting the theory of evolution and in conducting their own work within its framework. In fact in the 1860s a belief in Darwin's theory was considered modern and up-to-date.(6) It was much as in a country on the point of industrialisation in the twentieth century. It does not introduce the techniques that Britain was using in the beginning of the nineteenth century; it introduces those that are most modern and relevant to its needs. So in Russia the rising generation of biologists, who were bringing Russian biology up to European standards, accepted the theory of evolution as the most up-to-date explanation of the origin of species. Another important factor for the favourable reception of Darwin's ideas was that the older generation of natural scientists tended to favour some sort of transformism, and had thus created a sympathetic climate. Examples occur in the work of Roullier and Von Baer. By contrast there were no influential catastrophists. Finally it must be remembered that in the reforming climate of the 1860s Darwinism was looked upon as an essential part of progressive science, which was for the radical young intelligentsia a symbol of a better future and a better society. Many of the young biologists and geologists were part of this movement.

In consequence of this easy acceptance, biological and geological research in Russia after the ~~publication of~~ publication of the Origin of Species was carried out within the framework of the theory of evolution, although, naturally, not all the work in these fields was necessarily involved with problems directly connected with that theory. Many branches of biology and geology were purely concerned with the question of raising the standards of research to an international level. Nevertheless Russian scientists did make some original scientific contributions in support of the theory of evolution, primarily in the fields of embryology and palaeontology.

The embryological tradition, already established in

Russia by the work of Wolff, Pander and Von Baer, was developed into a strong Russian school of evolutionary embryology by Alexander Kovalevsky and Ilia Mechnikov, both students in the early 1860s.

Alexander Kovalevsky was born in 1840. He first trained to be a railway engineer, but then changed his mind and entered the department of physical and mathematical sciences at St. Petersburg University in 1859. He spent many of his student years in Germany where he studied under Bunsen and Bronn; he then moved to the Mediterranean shores of Italy, Naples and Messina, where he spent as much time as he could afford studying tiny sea organisms. He was appointed professor of zoology at Kazan in 1868. He spent only one year there and then moved to Kiev for five years. In 1872 he finally settled in Odessa, where his fellow scientist and friend Mechnikov was also working. Throughout his academic career Kovalevsky went abroad at frequent intervals to the Mediterranean to continue his field work. He was one of the chief initiators of the project for a marine biological station in Sebastopol but this was not officially opened until 1892.[7] In 1890 he was elected to the Academy of Sciences and he and his family moved to St. Petersburg. In this period he visited England twice, once in 1895 and once in 1899 when he was made a doctor of Cambridge University. He had been elected a fellow of the Royal Society in 1886. Kovalevsky died of a brain haemorrhage in 1901. Up to 1888 Kovalevsky's main scientific work was in the field of embryology. After that period he turned his attention more to comparative physiology; the study of the excretory processes of non-vertebrates. It is the early embryological work of the 1860s that was of most significance as far as the theory of evolution was concerned.

Between 1866 and 1871 Kovalevsky helped to establish through his work a genetic link between the vertebrate and invertebrate animal kingdoms. One of the difficulties facing the theory of evolution was the lack of intermediate types between the various groups and species. Darwin pointed out that it was not just a question of finding a type possessing characteristics from both groups between which it was intermediate but it was also a problem of finding a common progenitor for the two groups. He felt that embryology had an important part to play here:-

> "For the embryo is the animal in its less modified state; and in so far it reveals the structure of its progenitor. In two groups of animals, however much they may at present differ from each other in structure and habits, if they pass through the same or similar embryonic stages, we may feel assured that they have both descended from the same or nearly similar parents and are therefore in that degree closely related. Thus, community in embryonic structure reveals community of descent."[8]

Kovalevsky examined the embryological development of Amphioxus lanceolatus and Ascidia.[9] In 1865 Amphioxus was thought to be a lower vertebrate whereas the Ascidia were placed among the invertebrates. In modern classification they are both assigned to the sub-phylum protochordata, which together with the other sub-phyla, hemichordata and vertebrata, make up the phylum chordata. In both monographs Kovalevsky described in great detail, with accompanying diagrams, the development of the larva of these two organisms. When he had started his research his main aim had been to follow carefully the formation of the body cavity and the alimentary canal,[10] since previous observations had not made it clear from which part of the embryo they originated.

In both organisms he found that the segmentation cavity became the body cavity and that the alimentary canal was formed by invagination: the opening remaining from the first invagination became the anus and the mouth opening was formed later.[11] This process was common to a number of other organisms, belonging to the lower vertebrates and invertebrates, that Kovalevsky had also investigated, and he contrasted it with the process common to higher vertebrates whereby the alimentary canal was formed by fission of the primary single-layered blastoderm. In this latter case the primary germ layers originated as a result of the fission of the single-layered blastoderm. Kovalevsky saw a similarity in these two processes since in both cases the outer primary germ layer gave rise to the skin and body musculature and the lower primary germ layer gave rise to the alimentary canal.[12] He thought that this similarity was a possible indication of some type of developmental relationship between the different animal groups - the higher vertebrates, lower vertebrates and invertebrates - but he expressed this opinion in a characteristically cautious manner:-

> "Maybe it is still to early to make such generalisations but I think that the facts of embryology known to us at the present time justify such a parallelism."[13]

However, what was even more striking and original than this slightly vague correspondence in the processes of formation of the body cavity and alimentary canal, was the definite correspondence that Kovalevsky found in the embryological development of the Ascidia and Amphioxus, two organisms supposedly belonging to different kingdoms of the animal world.

In his monograph Kovalevsky observed that in the larva of Ascidians a number of features developed which then disappeared in the adult form. A tube was formed by the closing up of two dorsal ridges; this tube lay parallel to the embryonic alimentary canal, and he considered it to be an embryonic nervous system. In the centre of the tail of the larva there was a column of cells. Small bodies appeared between these cells; they grew and gradually squeezed the cells out of the central space of the tail. This was then filled with a thick jelly-like substance which Kovalevsky took to be the chorda dorsalis or skeleton of the tail. Both these developments present in the larva disappeared in the adult form of Ascidians. Similar developments occurred in the Amphioxus larva, but unlike in the Ascidean, remained through into the adult stage.(14)

In his monograph on the Ascidian Kovalevsky made a number of points relevant to the understanding of the facts he had observed. Firstly, the main distinctive feature in the development of all vertebrates was the formation of the dorsal ridges and their closing together to form the nerve tube. This was characteristic of vertebrates and had never at that time been shown to occur in the development of non-vertebrates. Kovalevsky referred to the fact that Huxley in his text-book on comparative anatomy considered it a primary characteristic distinguishing vertebrates from non-vertebrates.(15) The second characteristic feature in the development of vertebrates was that the body consisted of two parallel tubes - the lower one forming the intestine and the upper forming the nerve. This development was also found in Ascidia. The chorda dorsalis which was present in vertebrates between these two tubes was not prominent in Ascidia but was situated to the back of the larva. This chorda dorsalis was another characteristic feature of vertebrates. There had been much discussion before 1866 on whether the thick cord formed in the centre of the tail of the Ascidia larva could be considered to be a chorda dorsalis.

Kovalevsky compared the development of the cell cord of the tail of the Ascidia larva could be considered to be a chorda dorsalis. Kovalevsky compared the development of the cell cord of the tail of Ascidia with the development of the chorda dorsalis in Amphioxus. He found that they were quite similar, and concluded that it was quite correct to group them together both functionally and genetically.(16)

Thus according to Kovalevsky the larval stage of the Ascidia showed the characteristics of the vertebrates while its adult sessile form obviously belonged to the non-vertebrates. He concluded his monograph saying that he had mentioned all these points and observations because he felt they might throw light on and help explain the appearance and formation of vertebrate types.

Darwin himself was naturally interested in the results of Kovalevsky's researches and he mentioned them in detail in the second edition of <u>Descent of Man</u> published in 1874:-

> "M.Kovalevsky has lately observed that the larvae of Ascidians are related to the Vertebrata, in the manner of development, in the relative position of the nervous system, and in possessing a structure

> closely like the <u>chorda dorsalis</u> of vertebrate animals; and in this he has been since confirmed by Prof. Kupffer. M.Kovalevsky writes to me from Naples, that he has now carried these observations yet further, and should his results be well established, the whole will form a discovery of the very greatest value. Thus, if we may rely on embryology, ever the safest guide in classification, it seems that we have at last gained a clue to the course whence the Vertebrata were derived. We should then be justified in believing that at an extremely remote period a group of animals existed, resembling in many respects the larvae of our present Ascidians, which diverged into two great branches - the one retrograding in development and producing the present class of Ascidians, the other rising to the crown and summit of the animal kingdom by giving birth to the Vertebrata."[17]

Kovalevsky himself generally refrained from drawing such speculative conclusions from the results of his work, though there is no doubt that he was an evolutionist and that he understood the significance of his work for the theory of evolution. In 1872 he wrote to Bogdanov suggesting that perhaps it would be a good idea to write a popular article on the relationship between the vertebrates and invertebrates since nothing had at that time been written on the subject in Russian literature.[18] Unfortunately it seems that the article was never written.

Kovalevsky was not a scientist to make public pronouncements or to get himself involved in controversy.[19] A fellow student in Germany remembered him as a born scientist whose soul was merged with nature; he did not get caught up in metaphysical doubts but looked through his microscope.[20] In fact Kovalevsky spent the next twenty years on research into evolutionary embryology. The bulk of his monographs contained detailed scientific observations. Any speculations or generalisations he made were put forward cautiously and only when they were supported by indisputable facts. In his correspondence he displayed the same predominant interest in the details of his own scientific work, rather than in more general scientific speculations. In his letters to Mechnikov he mentioned Darwin and Darwinism rarely.

Ilia Mechnikov on the other hand was both a scientific worker and a populariser of the sciences, including the theory of evolution. He was five years younger than Kovalevsky, being born in 1845. He was a student first at Kharkov university, and then in Germany for a few years before being appointed professor of zoology and comparative anatomy at Odessa university in 1870. He and Kovalevsky worked there together from 1874 to 1882 when Mechnikov was relieved of his post in the reaction that followed the assassination of Tsar Alexander II in 1881. After leaving the university he was appointed head of the Odessa Bacteriological Station in 1886, at which post he remained only a few years. In 1890 he was invited to go and work in the Pasteur Institute in Paris and he remained there for the rest of his life. He was awarded the Nobel prize for his work on phagocytes in 1908 and died eight years later in 1916.

It is for his work in pathology, carried out in the latter half of his life, that Mechnikov is best known internationally: for his discovery of the infection fighting properties of white corpuscles and for his theories on aging and rejuvenation. However from 1870 to 1882, when at Odessa university, he concentrated primarily on research into the embryological development of invertebrates and his work at this time coincided with that of Kovalevsky. Their joint researches led them to the conclusion that in both vertebrates and invertebrates three embryonic germ layers were formed in the course of embryonic development. This was a further argument in favour of evolution since common embryonic development pointed to common descent.* Such research and conclusions were not unique to these two Russians but they do illustrate the fact that the two leading Russian embryologists were working within an evolutionary framework, and that the results of their work confirmed the evolutionary hypothesis.

Von Baer was still alive in this period but he himself did not contribute much to post-Darwinian embryology. As mentioned earlier when he moved to Russia in 1831 to join the Academy of Sciences the main emphasis of his work had changed from embryology to research into Russia's productive resources. Apart from field work that he carried out Von Baer helped to found the Entymological Society in 1859 and was its first president. In 1867 he moved to Dorpat, where he had been a student, and he spent the rest of his life there. His sight was failing and he could do little experimental work. In 1876 he died.

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*This interest in evolution was also present in his later work on pathology. In a lecture on the comparative pathology of inflammation Mechnikov discussed the question of the origin of multicellular organisms and had this to say: "Thus it is possible to find a link between the simplest and the multicellular animals through ciliated infusoria on the one hand and through organisms similar to the phagocytella on the other." (Efremov, ed., Khrestomatiia, p.676).

Von Baer was in his late sixties when the Origin of Species was published, yet although the main bulk of his scientific work was behind him, he did keep in touch with the new developments in embryology. In 1873 he wrote a paper opposing Kovalevsky's interpretation of his researches into the Ascidia and Amphioxus,(21) but these were the comments of an old man and did not have much effect on the school of rising young embryologists.(22)

Another area of Russian science in which a positive contribution was made to the theory of evolution was the field of geology. It has already been briefly mentioned that prior to Darwin geologists who accepted Lyell's uniformitarian theory as a working hypothesis did not attempt to come to terms with the serious implications of the tremendously long time scale it demanded, a time scale which clashed directly with the truths of genesis. Darwin's theory of evolution, however, which itself had been influenced by Lyell's theory, incorporated the same concept of change being the result of slow and small variations and consequently demanded the same long time-scale for the working out of this process. Although the geological and biological theories accommodated each other on these general points there were a number of particular facts known to geologists, especially in relation to palaeontology which were difficult to explain satisfactorally within the framework of Darwin's theory of evolution. Firstly, in the history of the earth there were no regular, continuous and progressive series of changes: periods of comparative stability had rather alternated with shorter periods of change. Secondly, at certain times the majority of existing forms had suddenly disappeared to be replaced by new fauna, that did not appear to be directly related to their predecessor. Thirdly, extinct forms did not close the gaps in the series of living forms. And finally, it appeared that all species had remained constant in the period of man's conscious history.(23)

Darwin's theory stimulated a large amount of work in palaeontology and these objections were soon answered. Among the palaeontologists who contributed in support of the theory of evolution was the Russian Vladimir Kovalevsky, the brother of Alexander the embryologist.

Vladimir Kovalevsky was born in 1842 and studied at the Law Institute in St. Petersburg; since he was there at the same time that his brother was at the university, he became acquainted with a number of natural scientists. He, himself, was at first attracted to chemistry and he made a number of translations of chemical books and papers. After finishing his law course in 1861 he had to go abroad because of illness and spent some time in London studying law. His life in the 1860s appears to have been colourful and lively. One biographer says that he took part in the Polish uprising of 1863,[24] (the Kovalevsky brothers were half Polish on their mother's side) and in 1866 he was reporting Garibaldi's Campaign for a Russian newspaper. At the same time, between 1863 and 1865, he published a number of Russian translations of works on the natural sciences including Lyell's Antiquity of Man. From 1868 Vladimir Kovalevsky began to study palaeontology seriously, though at the same time he became involved in a number of business ventures, mainly unsuccessful. He did not carry out any geological field work himself, but visited the museums of Europe and studied the bones of extinct animals that had already been collected. He wrote four scientific papers, including one presented to the Royal Society in London, and had been appointed to the chair of geology in Moscow university, vacated by the death of Professor Shchurovsky, when he committed suicide in a fit of depression in 1883.

Although Vladimir Kovalevsky did not leave much work behind him, he was highly regarded by his contemporaries, including both Darwin and Huxley whom he knew personally, for the research he had done into establishing evolutionary development series in palaeontology.

Kovalevsky was keenly aware of the significance of the theory of evolution for palaeontology. He described this in his first paper, 'On the Osteology of the Hyopotimidae',[25] which was presented to the Royal Society in 1873 and read by Huxley:-

> "The wide acceptance by thinking naturalists of Darwin's theory has given a new life to palaeontological research; the investigation of fossil forms has been elevated from a merely inquisitive study of what were deemed to be arbitrary acts of creation to a deep scientific investigation of forms allied naturally and in direct connection with those now peopling the globe, and the knowledge of which will remain imperfect and incomplete without a thorough knowledge of all forms that have preceded them in the past history of our globe."[26]

Kovalevsky set himself the task of acquiring this thorough knowledge of previous forms and he began with his study of the Hyopotimidae. He criticised the generally unscientific methods prevalent in palaeontology as a result of which, during the 25 years that this genus had been known to science nobody had ever cared to ascertain what its organisation really was, and not a single bone had been figured up to that day.(27) He believed that the Hyopotimidae were the direct ancestors of the Paradigitata, contrary to the generally accepted belief that the latter evolved from the Anoplotherium were exceedingly reduced, consisting of only two metacarpels and metatarsels, and it could not have given rise to the diversified Paridigitata which succeeded it in the miocene period, some of which have four completely developed metacarpels and metatarsels. The Anoplotherium must have been the last remnant of a dying-out branch. From this observation Kovalevsky drew some general conclusions about how evolution could take place:-

> "Besides it is a very general truth that only those families which were exuberantly developed in bygone times, presenting many subgenera and a great variety of specific forms of different size, have had any chance of leaving a progeny behind them."
>
> "Only such prolific types . . . sending branches in all directions, have any chance of not wholly dying out in the course of time. If, in the

> struggle for existence, through geological changes of climate, slow submergence of continents, and elevation of the former sea-bottom to the height of the Himalayas, many genera must have been destroyed, still some one branch may have remained, and by general modification through natural selection, and perhaps by the agency of some other unknown cause, has given rise to new genera and species better fitted for the changed circumstances of life."(28)

The Hyopotimidae was just such a prolific genera that Kovalevsky felt was necessary for continuing evolution, and after this very short general introduction of only a few pages, he spent over sixty pages describing the bone structure of the genera in great detail with accompanying diagrams.

Another important paper by Vladimir Kovalevsky was 'Sur l'Anchitherium aurileanse Cuv. et sur l'histoire paleontologique des chevaux' printed in the Memoirs of the St. Petersburg Academy of Sciences in 1873.(29) In it he showed that the Anchitherium was an intermediate link between the eocene Paleotherium medium, whose feet had three toes and leant on all three toes, and the miocenepliocene Hipparion, whose side toes were shortened and did not touch the ground. This was one of the first attempts in Palaeontology to build up an evolutionary development series for a single species. Professor Othniel Charles Marsh (1831-99), the American palaeontologist, later much improved and filled in the development series of the horse.

In this paper Kovalevsky followed the same method he used in the one previously discussed. He began with a short theoretical introduction, the bulk of the paper consisting of very detailed descriptions of the various bones of the animal. In his introduction he again discussed Darwin's theory and pointed out how one of the chief obstacles to that theory was the absence of missing links between different species. Kovalevsky felt that it was possible to remedy this since palaeontology had up to then only scratched at the surface of the fossils present in the strata of the earth. Each dig in unexplored regions produced new material. He hoped to bring out a series of monographs on missing links, his paper on the Anchitherium being the first; he found the Anchitherium to be a beautiful example of the phenomena:-

> "And really the Anchitherium is such an intermediate, transitional genus through the structure of its skeleton, that if the theory of transmutation did not already have a firm base, it

> could be one of its most significant supports. Its every bone, every bone facet, every joint strive to change in the given direction, . . . here is the place of evolution, it is impossible to suppose the existence of special acts of creation for characteristics that are transitional."(30)

He placed the evolutionary line of the horse in the following order: Palaeotherium medium, Anchitherium, Hipparion to the modern horse. He described how he thought the process of development from one genus to another was brought about:-

> ". . . new characteristics do not appear or old ones disappear suddenly, from one animal to the next; both the appearance and disappearance of characteristics takes place slowly, so to say, in a fluctuating way. A characteristic, which was normal, begins to sometimes disappear, then it becomes indifferent, i.e. is present as often as it is absent, finally it becomes rare and completely disappears."(31)

He gave the example of the small front molar tooth which was always present in the Anchitherium, was absent as often as it was present in the Hipparion and in the modern horse was quite rare.

It is perhaps ironic that none of the three species Kovalevsky placed in his developmental series for the horse are in fact direct progenitors of present-day horse according to its modern evolutionary order of development. The Palaeotheres, Anchitherium and Hipparion were all members of branches that became extinct. There is no direct line of development between the palaeotherium and the anchitherium, though the hipparion did develop both as an offshoot of the anchitherium branch as well as from the main line (merychippus).(32) Despite the fact that his results do not agree exactly with contemporary knowledge of the subject Kovalevsky's approach, method and results do not lose their validity for the period when he was working; his researches were extremely important examples of evolutionary palaeontology.

Darwin's high opinion of his work is recorded in the following story. When Timiriazev visited Darwin in 1877 Darwin mentioned the name Kovalevsky several times. Timiriazev asked whether he was referring to Alexander, the zoologist. Darwin replied: "No, Vladimir; in my opinion his palaeontological researches have even more significance than the zoological work of his brother."(33) Vladimir also had a high opinion of Darwin and dedicated his 'Monograph on the genus Anthrocotherium' to him.

Kovalevsky's work was important for the theory of evolution but there was too little of it and he died too young for him to have made a real impact on and contribution to either the science of geology as a whole or to Russian geology in particular.* Geology in Russia in the 1860s was not a very well developed science. In 1863 the new university charter provided for one department which dealt with geological research and then it was called the department of geognosy and palaeontology. This was renamed the department of geology in 1884 when it was combined with the department of mineralogy which had been separate under the 1863 charter. In 1860 the staff at the universities was unimpressive. In St. Petersburg Professor Kutorga was supposed to cover geology as well as all his other subjects; in Moscow the department was headed by Professor Shchurovsky. However 1860, as in other branches of science, did herald a new spirit in geology. Timiryazev describes the contrast between the ideas of

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*In discussing contributions made by geologists and palaeontologists in support of the theory of evolution, Timiriazev makes no mention of Kovalevsky while at the same time mentioning the American geologists, Marsh and Gaudry. (Charl'z Darvin i ego uchenie, p.95)

Hoffman (the younger) who came to St. Petersburg at this time and those of the elder Hoffman, who had been invited to Moscow university at the beginning of the century. The latter was remembered for his boring descriptions of rocks with Russo-German names, while the former used the contemporary ideas of Lyell, which in fact were only first translated into Russian in this period though they had been known to the scientists for many years.(34) Another German geologist who worked in Russia from 1857 to 1888 was Hermann Trautschold. He was one of the first scientists to mention Darwin's theory in public in Russia and he found that his researches confirmed it.

The researches of Vladimir Kovalevsky in the field of geology and of Alexander Kovalevsky and Ilya Mechnikov in the field of embryology had probably a more direct bearing on the theory of evolution as such than any other work done in this period in Russia, since they provided facts in direct support of the theory and helped overcome scientific objections raised against it. Yet, although other work carried out in Russia after 1860 in the fields of biology and geology may not have the same immediate relevance for the theory of evolution it did lie within the framework of that theory.

A strong scientific school that developed in the post-reform period was that of physiology. In the early 1860s this subject was not purely confined to the scientists but was one which captured the public imagination. G.H.Lewes's Physiology of Common Life had been translated into Russian(35) and was widely read by the general public; in 1860 Chernyshevsky wrote an article entitled 'The Anthropological Principal in Philosophy'(36) in which he dismissed all dualist explanations of life; the radical intelligentsia saw physiology as a rational weapon against the mystique and tradition of the old way of life; the general public saw it as a short and popular way to attaining a veneer of the respectable scientific outlook. This popular appeal and dissemination did not detract from the quality of the work of the scientists, included among whom were Ivan Sechenov and his pupil Ivan Pavlov.

Ivan Sechenov could be called the father of the Russian physiological school. He was born in 1829 and studied on the medical faculty of Moscow university between 1850 and 1856. He went abroad where he studied under Helmholtz, Dubois-Reymond and Claude Bernard among others. He taught at the Medical-Surgical Academy of St. Petersburg for ten years before he was appointed Professor of Physiology at Odessa university in 1870. There he remained five years before moving first to St. Petersburg university and then to Moscow university. He died in 1905. When Sechenov returned to Russia in the late 1850s from his studies abroad he was equipped with the all-round chemical, physical and vivesectional techniques that had transformed west European physiology in the previous ten years. Timiryazev commented that, with the exception of Helmholtz, it was unlikely there was another scientist at that time with such a complete grasp of subjects, ranging from solutions of gases to psychology.(37) Sechenov was a true representative of contemporary trends in physiology, especially those present in Germany. He was a materialist in the sense that he opposed dualist theories of matter and always attempted to explain all processes in scientific terms; he looked for physiological answers to psychical phenomena.

His most important scientific contribution was to the study of the central nervous system. In 1863 he outlined a comprehensive reflexive theory of behaviour in an article entitled 'Reflexes of the Brain'.(38) This line of research was developed further by his pupils I.P.Pavlov and V.M.Bekhterov and was the basis of the Russian school of physiology. Sechenov was also well-known for his discovery of the process of inhibition in the nervous system, a process which was recognised after Sechenov's researches to be just as an essential part of the nervous system as the process of stimulation.

While this work of Sechenov and other Russian physiologists did not have the direct relevance for the theory of evolution of the work of the brothers Kovalevsky, it was carried out within the same broad framework. Sechenov was attempting to explain human psychological phenomena in physiological terms with a theory of conditioned reflexes. These reflexes he took to be the result of long evolution over thousands of years, a result of stimulation from the outside and not of any vital factor like a soul. Treating man's psychology in the same way as that of animals was a logical extension of the theory of evolution, although

Sechenov first outlined his theory some years before Darwin himself dealt with man in The Descent of Man.

The zoological sciences in Russia were dominated in the second half of the 19th century by the two schools of embryology and physiology. This was a dominance that had partially arisen from the fact that the student scientists of the 1860s had been influenced by and attracted to the twin symbols of contemporary science at that time - the search for general theories, such as the theory of evolution, and research into microscopic organisms.(39) This did not mean, however, that no work was carried out in other branches of zoology, related to the macrocosmic world. Much of the fauna and flora of the large Russian Empire was still unknown at the time of the publication of the Origin of Species and it was necessary that the straightforward collection, identification and classification of fauna and flora should continue after 1859. This was done, though not on the same wide scale as had dominated in the first half of the 19th century.

The question of classification was of great importance for the theory of evolution. Before 1859 species had been regarded as separate creations; after 1859, in the light of the theory of evolution, they were seen as living populations in nature, occupying dimensions in space and time and varying under the impact of selection in multiple ways. In actual practical terms this new conception of species had little effect on methods of classification, though it did end the need to differentiate precisely between species and varieties. It was still necessary to regard species as separate for the purposes of classification, and many evolutionists continued to believe in polyphyletic origin - in other words a number of parallel lines of evolution, not necessarily evolution from a single type. There was little agreement and no real progress in advance of Cuvier's classification system.(40) The most profitable line of research was perhaps for transitional types and on those species that occupied an uncertain position in the classification system. The work of Kovalevsky and Mechnikov in the former field has already been discussed. Russian scientists who contributed to the latter field included A.N.Beketov, who crossed out the whole Linnaean class of lichens and placed them in the Fungi class.(41)

Among scientists who continued to do research specifically into the macrocosm, one of the most important was Nikolai Severtsov, who, after his ecological study written in 1855, had helped to lay the foundations of zoogeography as a science in Russia. He worked on the zonal distribution of animals, making several expeditions to Central Asia and writing in 1873 a book entitled The Vertical and Horizontal Distribution of Animals in Turkestan. In the field of geographical distribution both Darwin and Wallace had assumed that each species had arisen once and in one place only, and that it had spread further afield from its original place of origin. They were mainly interested in this question of migration and in the characteristic mammals of each region. Interest in the direct relation of the organism to the environment,[42] a trend represented by N.Severtsov, only generally appeared later in the century.

Other scientists continuing to work in the macro#cosmic included Karl Kessler, professor of zoology at St. Petersburg university, who was not an original thinker, but who did a lot of research into Russian fauna, especially birds and fishes. Most of the Academicians can also be included into this category, thus continuing the tradition they had established prior to 1859 but perhaps also emphasising the gap between their science and that of the younger generation in the universities. Johann Brandt worked mainly on systematics, palaeontology, zoology and zoogeography. Alexander Middendorff was a well known explorer and ecologist; Schrenk made an ethnographical study of the tribes of the Amur basin.

In the field of botany macrocosmic studies were carried out by Russian collectors and explorers but again, as in the zoological field, the main emphasis in the universities where the bulk of the scientists were concentrated, was into the histology, anatomy and physiology of plants.

The father of this trend, which only appeared in Russian universities in the mid-1850s, was Professor Lev Tsenkovsky. He was one of the founders of protistology and bacteriology. He studied the history of the individual development of lower plants, such as fungi, water plants and bacteria, and of lower animals, such as infusoria, radiolaria, and the results of his work showed that there was no sharp boundary between the plant and animal world, a relevant point for the theory of evolution.

Tsenkovsky had to leave St. Petersburg university in 1859, for reasons of health. His place was taken by two botanists, Andrei Beketov and Andrei Famintsin, since the 1864 university charter divided the botany chair into two departments: morphology and systematisation, and anatomy and physiology.

Andrei Beketov, appointed professor of the department of morphology, was one of the first in Russia to study experimental morphology; he also worked on botanical geography. Beketov was most concerned with the dependence of the structure of plants on the surrounding environment; he considered the two chief bases of evolution to be the ability of a given organic form to change, adapting itself to the environment and its ability to pass on by heredity the acquired variations.(43)

Andrei Famintsin was appointed to the other chair in botany, the department of plant anatomy and physiology, in 1867. He was ten years younger than Beketov and had been the first Russian botanist to choose physiology as his speciality. His main work was done on the problems of photosynthesis and symbiosis in plants. Famintsin was the first of a number of plant physiologists to work in St. Petersburg university. Among these were Ivan Borodin and Mikhail Voronin. Borodin finished studying at St. Petersburg in 1869 and he became a professor there in 1880. His main work was on plant respiration and chlorophyll and he also studied the connection between the inner structure of the plant and its systematic position. Voronin was a rare species of scientist in Russia as he occupied no university post. He had his own independent means and worked with Famintsin in the botany laboratory of the Academy of Sciences, which was also situated in St. Petersburg. His main research was into fungi.

The study of plant physiology was not confined to St. Petersburg. Kliment Timiriazev was a very fine plant physiologist teaching at the Petrovsky Agricultural Academy in Moscow. He had studied at St. Petersburg university from 1861 to 1866. In 1862 he had trouble with the university authorities because he refused to sign a declaration that he would not take part in any political activities, but he was later allowed to continue at the university. He finished with a gold medal and was sent abroad in 1868 to prepare for a professorship. On his return he was appointed professor at the Petrovsky academy where he remained until 1892. Timiriazev's researches followed the same trend already established in St. Petersburg university by Famintsin. They included the study of the composition and optical characteristics of chlorophyll; its origin; the physical and chemical conditions for the decomposition of carbon dioxide; the determination of those components of the sun's ray that take part in the process of photosynthesis; the investigation into the fate of those rays in the plant; and, finally, the quantitative relation between the absorbed energy and the work produced.(44) To help in his work Timiriazev built the first hothouse in Russia in the early 1870s, very soon after they had first appeared in Germany.

The work of both the plant experimental morphologists and plant physiologists overlapped and a number of botanists were occupied in both fields. The relevance of the work done by them to the theory of evolution was quite considerable since they were dealing with problems such as the reason for certain plant structures, the influence of the environment on structure and physiological processes, the question as to whether plant processes were essentially similar to or different from those of animals. All the botanists working on these problems were evolutionists; some even couched their work in Darwinian terms. For example Nicolai Levakovsky, a botanist from Kazan, wrote a monograph in 1871 and 1872 entitled 'On the question of the displacement of one type of plant by another'.[45]

He looked at the problem from two angles: the relationship of the plant's seed to moisture; and the significance of the seeds and other parts of the plant existing in the soil. His conclusions were in agreement with those of Darwin that in the struggle for existence only those forms were preserved which were best able to counteract harmful outside influences.[46]

In Russia the period when the sciences of biology and geology first entered the mainstream of contemporary science coincided with the publication of the Origin of Species. The development of these sciences in Russia in the second half of the 19th century followed a similar course to that in the rest of Europe towards further specialisation and towards an historical, evolutionary approach. However, what was specific to the Russian situation, a partial result of the fact that the coming-of-age of biology and geology occurred when it did, was the absence of scientific work done outside the framework of evolution or in direct opposition to the theory. In fact, a survey, based on the Royal Society catalogue for 1864 to 1883, of the papers printed by 33 leading Russian scientists did not reveal any work done on vitalism, catastrophes or similar elements of anti-evolutionary science.

CHAPTER VI

Scientific Criticism of Darwinian Concepts.

As pointed out earlier the theory of evolution and the theory of natural selection were two separate concepts and the acceptance of one did not necessarily entail the acceptance of the other. In Russia the scientists accepted and worked within the framework of the concept of the evolution of the species from the very beginning. Their attitude to the concept of natural selection was, however, both more equivocal and more critical, an attitu#de common to most scientists in Europe and America at this time.

Natural selection involved three ideas - variation, heredity and the struggle for survival. At the time of the publication of the Origin of Species and for many years after there was a lack of scientific knowledge about all three of these ideas and this inhibited a definite scientific understanding of the process of natural selection. One of the most important difficulties was in the field of heredity since very little was known about the actual mechanism of inheritance before 1900 when Mendel's experiments and laws were rediscovered and when modern theories of inheritance began to be developed. At the time of Darwin the generally accepted inheritance theory was the theory of blending inheritance, according to which the characteristics of the parents were blended together in the offspring. This raised a number of difficulties for natural selection, as a British engineer H.C.F. Jenkin~~s~~ pointed out in 1867, since if the theory of blending inheritance was true then the effect of any one variation in the parent would be halved in the offspring and from a long term point of view blending inheritance would tend to result in stable uniform species, not evolving varieties. Darwin was aware of these difficulties before Jenkin~~s~~'s review appeared.[1] He tried to deal with them firstly by allowing that a number of individuals with similar characteristics could appear at one time and secondly by emphasising the negative aspect of selection, pointing out that the unfavoured organisms would be wiped out leaving the favoured organisms to survive and thus reducing the problem. Darwin did agree with Jenkins that blending inheritance would prevent large variations or saltations from being of use in evolution since these tended to appear singly and so would be swamped and easily disappear through crossing. The difficulties caused by blending inheritance led Darwin to rely on the simultaneous appearance of considerable numbers of small individual and favourable variations for the working of natural selection.

At this point other difficulties arose since again little was known at that time about the scientific causes of variations in plants and animals. It was well known that each member of a species differed in some slight way from other members and, as long as it was accepted that natural selection could achieve evolution using the chance variations thrown up by nature, there was no real need to question or to know the scientific cause of these variations. However, as soon as natural selection encountered difficulties over blending inheritance and Darwin had to introduce the idea that a considerable number of small individual variations were necessary for natural selection to work on, then the question arose - why should a large number of similar variations appear at the same time?

In the first edition of the Origin Darwin had pointed out the complexity of the laws governing variability:-

> "Variability is governed by many complex laws - by correlation of growth, by use and disuse, and by the direct action of the physical conditions of life."[2]

He also emphasised that little was known about these laws.[3] Because of the swamping effect of blending inheritance Darwin laid more stress on the influence of the environment in causing variations and on the inheritance of these acquired characteristics in the later volumes of the Origin of Species:-

> "This [the modification of Species] has been effected chiefly through the natural selection of numerous successive, slight, favourable variations; aided in an important manner by the inherited effects of the use and disuse of parts; and in an unimportant manner, that is in relation to adaptive structures, whether past or present, by the direct action of external conditions, and by the variations which seem to us in our ignorance to arise spontaneously."[4]

Darwin had to place this emphasis on the inheritance of characteristics acquired through use and disuse and through the influence of the conditions of life because without these two extra factors it appeared that the chance variations thrown up by nature would not be sufficient for natural selection to overcome the effect of blending inheritance.

Darwin also outlined in 1868 an hypothesis of inheritance to explain scientifically the inheritance of acquired characteristics. This hypothesis was called pangenesis and it assumed that all the cells of the body gave off small particles or gemmules which became accumulated in the germ cells and through them transmitted to the next generation the exact condition of the somatic cells from which they arose. In this way a variation in the somatic cells would be inherited by the next generation.

The third idea necessary for the theory of natural selection was that of the struggle for survival, which had been derived from Malthus's Essay on Population. Confusion here arose firstly over the question of the validity of applying an argument based on human population to the organic world and secondly over the actual struggle itself, whether it took place primarily between members of the same species or whether it was basically a struggle between different species; in either case there was the problem of defining 'fittest' or those qualities which were to win the struggle.

The problem of the definition of 'fittest' was also closely related to the problem of progress. There seemed no valid reason for natural selection, which was based on chance variations, to have resulted as it had in the apparently progressive development of the organic world. And there were a number of factors which seemed to show that natural selection was not necessarily progressive. Firstly in many cases it had resulted in the development of apparently useless organs and characteristics. Secondly, it was thought that it would be very difficult to distinguish a useful from a useless characteristic in the early stages of evolution of a highly complex organ such as an eye. It seemed that some other principle besides natural selection was needed to account for the progressive evolution of the natural world. Darwin countered these difficulties in a number of ways. He realised that if it was proved that "any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications"[5] then his theory would absolutely break down, but he believed that the power of natural selection was such that it could pick out and retain over a countless number of generations numerous, small variations and that this process would eventually result in the evolution of the complex organs now present in living organisms.[6] Darwin felt that the fact that he had not at first considered sufficiently the existence of structures which, as far as it could be judged at that time, were neither beneficial nor injurious, to be one of the greatest oversights in his work.(7) He did however feel that many such structures, now considered useless, might later be shown to be useful. For example his mechanism of sexual selection, which he saw as an important complementary factor in the process of natural selection, explained the function of a number of apparently useless sexual characteristics.*

The problems encountered by the concept of natural selection resulted in western Europe and north America in the appearance of numbers of new supplementary theories that attempted to answer them. Primarily these can be divided into two schools of thought - the neo-Darwinist(8) and the neo-Lamarckist - but there were many areas where ideas overlapped.

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*Darwin saw sexual selection as the result of competition between males for a mate or the selection of males by the females. The reproductive advantages accrueing to the species through this type of selection lay on the borderline between physiology and psychology, and were not immediately recognisable as advantageous within the normal context of survival.

The neo-Darwinist school, led by Alfred Russel Wallace,[9] believed firmly in the supreme importance of natural selection but because of the difficulties connected with this concept a number of neo-Darwinists introduced additional theories, sometimes even at the expense of natural selection. The most important representative of this school was August Weismann,[10] the German biologist, who, with his theory of 'germinal selection' carried natural selection into the germ cells of the individual. In his work on heredity Weismann distinguished clearly between the germ cells and somatic cells of an organism so that any stimuli affecting the latter had no effect on the former. The germ cells were continuous from generation to generation and they alone were responsible for inheritance. Evolution was due to an accumulation of variations induced in the germ plasm. This theory of heredity opposed the arguments of the neo-Lamarckists and of Darwin himself over the possibility of the inheritance of acquired characteristics, and although it was purely speculative it did help to explain many of the problems facing evolutionary biologists. Other supplementary theories put forward by neo-Darwinists included the theory of isolation[11] which countered the difficulties of blending inheritance by saying that one of the basic conditions necessary for natural selection to take place was either biological or geographical separation of the favoured individual from other members of the species.

The neo-Lamarckist school stressed the role of the environment and the inheritance of acquired characteristics as of chief importance in the process of evolution. The main scientific advocates of this school were French and American.(12) In England it was represented by Herbert Spencer and Samuel Butler, two interesting and influential thinkers, but not in any way practicing scientists.

Existing parallel, and sometimes in conjunction, with these two schools of thought were other trends of ideas. The problem of the possibility of the progressive development of the organic world being dependent on the natural selection of chance variations was removed by the orthogenetic theories of many scientists. The basic idea of orthogenesis was that evolution took place in a given direction over a prolonged period of time, controlled primarily by an inherent directing force. Natural selection was delegated to a secondary role. Another theory, in some ways complementary to that of orthogenesis, was heterogenesis or the mutation theory of evolution. This theory involved the concept of an inherent ability of the organism to change, a concept close to orthogenesis, with the idea that actual change was not only the result of numerous minute variations but also the result of sudden sharp variations or mutations.(13) This latter aspect was the most significant and in fact was a bridge between the ideas of the formulative period of the latter half of the nineteenth century and the modern synthetic period starting after the rediscovery of Mendel's laws.

The scientific criticisms and schools of thought that emerged in western Europe and north America around the problems of natural selection were not unknown to Russian scientists. Even when relevant works and articles were not translated into Russian, most Russian scientists could understand at least one foreign language and all the most important foreign scientific reviews were available to them. In Russia itself, however, the theory of evolution was accepted and assimilated from the very beginning in an atmosphere conspicuously lacking in any scientific criticism of the theory. There was no scientist so strongly opposed to the theory that he became a focal point of attraction for similar opposition, such as occurred in England behind Robert Owen and in America behind Agassiz. However, together with a general acceptance of the idea of evolution there did also exist from the very beginning a certain critical attitude to Darwin's concept of natural selection, although the attitudes of the Russian scientists and popular writers on this matter did not form any specific schools of thought as have been described as existing in western Europe.

In most of the articles, discussed in Chapter IV, which helped to introduce Darwin's ideas to the Russian public, there existed, alongside praise for Darwin's work and ideas, certain reservations with regard to natural selection. For example Professor Kutorga wrote:-

> "Of all the theories on the origin of the species, Darwin's is without doubt the most logical, the most satisfactory and at the same time one of the most simple. It has given science the truth that natural selection is a powerful factor in the formation of species. Perhaps other equally important factors will be discovered because, despite all our wonder at Darwin's theory, we don't

> find that it contains a complete solution to the problem.
> "This theory in a very definite way has brought us closer to the wished-for solution - and that we can already call a real victory."[14]

Strakhov in the article he wrote in 1862 came to a similar conclusion. He felt that Darwin's theory held weight and was important because it was an attempt to explain the mutability of species scientifically. However he felt there was an inner weakness to Darwin's argument since one of the factors upon which natural selection was based, reproduction or heredity, was not yet understood scientifically and so, he felt, that Darwin could not be said to have solved all the laws of development.[15]

In 1863 the 18 year old Mechnikov, in his unpublished review of the Origin of Species, actually concluded his piece by rejecting Darwin's theory,[16] by which he presumably meant natural selection, since at the same time he affirmed his belief in the mutability of the species. The main faults he found in Darwin's ideas were a false generalisation of Malthus's theory and the attribution of too much significance to natural selection and extinction, faults which Mechnikov felt arose from a too shallow obversation of the influence of the environment on the organism.(17)

This critical attitude to the concept of natural selection, present in the attitudes of scientists and popular writers on science from the beginning of the 1860s and throughout the rest of the 19th century, never assumed dimensions of any great significance in either the public or scientific discussion. However, one rather abortive public polemic on Darwinism did take place in Russia in the 1880s. The main protagonists were N.Y.Danilevsky, N.N.Strakhov and K.A.Timiriazev and the overt reason for the polemic was the publication in 1885 of a work by Danilevsky entitled Darwinism.

Danilevsky was born in 1822. He studied in the natural science department of St. Petersburg university, specialising in botany, from 1843 to 1847. In 1853 he took part in an expedition, led by Von Baer, to examine the state of the fisheries on the Volga River and Caspian Sea. From then on Danilevsky was occupied mainly with similar research. His work took him on a large number of far-flung expeditions as Russia's fishing industry was very extensive. In the 1880s he was also active in a campaign to control the pest Phylloxera which was attacking the vineyards in the southern part of the Russian Empire, as it was in France. Besides his scientific work Danilevsky was very interested in the history of Russia and her relationship to the rest of Europe, taking an extreme Slavophil attitude on these questions.

Danilevsky died just a few days before the publication in 1885 of his book Darwinism, which was in essence a collection of all the criticisms that had been made in the previous twenty years against Darwinism, mainly by foreign scientists and writers.* Upon publication it was generally ignored in the Russian reviews. Scientists read it and laid it aside, finding nothing new in its criticisms.(18) It was presented to the Academy of Sciences for a prize but received nothing.(19) Danilevsky's close friend, Strakhov, then decided that he must break the silence surrounding the book.

*Albert Wigand (1821-86), the scientist most favoured by Danilevsky, was a German botanist who, like Danilevsky, could not accept Darwin's theory for religious and philosophical reasons and wrote a number of works criticising the theory; (see also p243-4)

Strakhov like Danilevsky was a Slavophil in outlook. He was born in 1828 and studied mathematics at St. Petersburg before transfering to the natural sciences. However in 1857 he failed to obtain his master's degree in zoology and a few years later he left off teaching science in order to collaborate with the Dostoevsky brothers on their review _Time_. Religion was central to Strakhov's philosophical ideas[20] but he also believed in the concept of a rational natural science[21] and in debate he stood in defence of rational principles.

He decided to break the silence surrounding Danilevsky's book for two reasons. Firstly he wished to make sure that this masterpiece, as he termed it, by his close and dear friend obtained a proper hearing in Russia. He really feared that it might be ignored, and he said as much in one of his essays, where he describes the reasons for the polemic:-

> "Surely no effort was necessary to save his [Darwin's] book and theory from oblivion? Meanwhile, just that very fate threatened Danilevsky's book; it could have happened that a brilliant work would be completely ignored, would pass by without any comment."[22]

Secondly he wanted to topple Darwin and counter the position, then existing in Russia as he thought, where everyone blindly worshipped the West.*

He broke the silence and drew the public's attention with an article published in 1887 entitled 'A Complete Refutation of Darwinism'(23) which claimed that the silence following the appearance of Danilevsky's book was a sign that the Darwinists had been defeated and could find no answer to Danilevsky's arguments and criticisms. On April 2nd, 1887, two months after the appearance of Strakhov's exultant essay, K.A.Timiriasev gave a lecture in the Moscow Polytechnical Museum called 'Can Darwinism be Refuted?'(24) It was aimed against the ideas of Danilevsky and Strakhov and was greeted with cheers and roars of delight from the audience.(25) The lecture was later printed in the May and June issues of the review <u>Russian Thought</u>. This refutation was soon followed up by Strakhov. In the November and December issues of the <u>Russian Herald</u> he replied in an article headed 'The Usual Mistake of the Darwinists.'(26)

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*In a letter he wrote to Tolstoy in 1889 he said ". .The young have an enormous thirst for knowledge. . it is necessary to quench it and to destroy that mirage of false knowledge on which they fall unrestrainedly when nothing else is in sight. To shake Darwin's authority - what a blow, what a sobering!. ." (Tolstovsky Muzei, vol II, perepiska L.N.Tolstogos N.N.Strakhovym, 1870-94, pp. 381-2.)

Timiriazev did not reply for over a year and then an article by him, 'The Powerless Fury of the Anti-Darwinists',[27] appeared in 1889 in the May, June and July issues of Russian Thought. In the introduction Timiriazev expressed his reluctance to take part in this polemic as it took up much valuable time, but he felt that it was his duty to show that Danilevsky had not refuted Darwinism, thus signifying that Strakhov had found some support for his side.[28] This essay signalled the real end of the polemic. Strakhov later wrote a short summarising article 'The Quarrel Resulting from the Books of N.Y.Danilevsky' published in the December issue of the Russian Herald. Here he discussed briefly the polemic with Timiriazev on account of Danilevsky's book Darwinism, as well as another one that he had been carrying on with a well-known writer, Soloviev.

K.A.Timiryazev and N.N.Strakhov were the main protagonists of the polemic but they were not the only ones. A.S. Famintsin, a professor of plant anatomy and physiology at St. Petersburg university and an extra-ordinary Academician, wrote an article criticising Strakhov and

Danilevsky's book in the February, 1889, issue of the Herald of Europe called 'N.Y.Danilevsky and Darwinism. Has Danilevsky refuted Darwinism?' Strakhov replied in the April issue of the Russian Herald in an article 'The Judgement of A.S.Famintsin on Darwinism'. The Academician Karpinsky also published a criticism of Danilevsky in the Herald of Europe in 1889. Chernyshevsky wrote an article supporting the theory of evolution but attacking Darwinism as such, called 'The Origin of the Theory of the Beneficial Struggle for Life' which was published in 1888 in the review Russian Thought. He did not mention the polemic, but presumably had been roused to write by the discussion going on at that time.

The discussion, like the main issues that arose out of it, was both of a scientific and of a cultural nature. The latter cultural aspect will be discussed in more detail in Chapter VII. At this point the scientific issues and their bearing on natural selection and other Darwinian concepts will be examined.

In the conclusion to his work Danilevsky summed up the fifteen scientific problems which in his mind made both natural selection and evolution impossible:-

1. Animals were chosen for breeding and plants for cultivation because of their innate ability to vary. Thus any analogy between artificial and natural selection was invalid.
2. Domesticated animals, if allowed, reverted to their original wild type. Darwin himself had mentioned this and thus implied that the species type retained some irrepressible force whatever influences it might have been subjected to under domestication.
3. The conclusion that natural selection was that much stronger than artificial selection, as nature was than man, was a pure sophism. Nature could not build machines.
4. Divergencies between domestic types never reached the same scale as differences between species.
5. The importance of selection was grossly exaggerated. The most important and the largest variations that appeared in domestic animals were not the result of selection but of a spontaneous saltation.
6. From these previous points Danilevsky concluded that the analogy between artificial and natural selection suggested by Darwin's theory lost its validity, or was, at any rate, reduced to the smallest proportions.
7. The struggle for survival lacked extreme intensity, constancy and unity of direction, the qualities necessary for the action of selection.
8. The intensity and general presence in time and place of the struggle for survival was overestimated by Darwin.

9. Crossing had to annihilate any variations. The struggle for survival did exist and it was to Darwin that we had to give the credit for pointing it out, but it did not have the power of selection. It was a bio-geographical principle, explaining the geographical distribution of organisms but not having any biological significance.
10. The existence of useless, harmless or purely morphological characteristics could not be explained by the theory of selection.
11. If the world had developed according to Darwinian principles then it would be entirely different from the contemporary world.
12. If natural selection existed then transitional forms should have been found, but there were none.
13. There was insufficient palaeontological evidence.
14. There was no evidence that when an old species died out a new one was formed at the same time.
15. The length of time necessary for the Darwinian process was far in excess of the period of time that the earth had existed.(29)

None of these points were original to Danilevsky as Academician Famintsein pointed out:-

> "Out of all the objections raised by him [Danilevsky] a comparatively very small number belong to the author of "Darwinism". The overwhelming majority of them, and moreover the most weighty ones, were

> put forward in greater or lesser detail by his predecessors (Nägeli, Agassiz, Von Baer, Quatrefages, and especially Wigand are all used later on). Danilevsky only elaborated these objections and in places added more examples . . ."(30)

In the actual public polemic between Strakhov and Timiriazev the scientific problem that caused the most heat was blending inheritance and its consequences. Strakhov argued, on the basis of Danilevsky's ideas, that blending inheritance would lead to the elimination of any variation that might arise within the species. Therefore for natural selection to take place, crossing had to be eliminated. Danilevsky had admitted that Darwin himself had taken this criticism into account but he felt that by so doing ~~so~~ Darwin had disproved his whole theory since to allow that a new variety could be formed from a large number of individuals which all had to a greater or lesser degree the given favourable characteristic was to deny one of the basic precepts of the theory - chance. In answer to these points Timiriazev put forward his own ideas of how the effect of blending inheritance could be countered. Like Darwin he believed that a certain number of individuals with the favoured characteristic would have to arise at one time, and he thought this was possible either as the result of crossing or as the result of the influence of internal and external factors. He also mentioned the work of Nageli[31] that had shown that varieties, differing very little from each other, could live side by side without crossing, a factor which would help each variety to preserve and develop its own specific characteristics.[32]

Arising out of the discussion on blending inheritance was the question of pure-bred species. Danilevsky had said in his book that Darwinism demanded that the new form which appeared in a number of individuals should be preserved completely inviolate as a pure breed. Timiriazev objected that Darwin had never said this nor had he claimed that natural selection could retain individual variations in their pure form.[33] Timiriazev argued that selection did not necessarily preserve a variation in its pure form. Selection only preserved those individuals with new variations that appeared in some number, and he argued that crossing might lead to such a situation: a single individual that had appeared with a variation might, through crossing, produce a larger number of individuals with the same or modified variation. In Timiriazev's mind crossing was a condition of nature which meant that natural selection needed very long periods of time to achieve a result. The fact that natural selection took centuries of time and artificial selection only decades to achieve the same result was caused by the factor of crossing.(34)

Closely linked with the question of swamping inheritance was that of the struggle for survival and the survival of the fittest. Danilevsky had recognised the geometrical progression in the increase of plants and animals, and had acknowledged Darwin's contribution to an understanding of the struggle that resulted from it. He felt, however, that natural selection could only occur if there was very fierce struggle among the organisms. As this did not always occur, for instance in areas where there was plenty of room for an increase in the plant and animal populations, then natural selection would not necessarily result. Danilevsky also formulated a theorem defining the conditions under which the new variation could win the battle against the old form:-

> ". . . the advantage [of the new form] must be that much greater [over the old form] as its numbers are smaller [than those of the old form]. . . "(35)

He then concluded that as a sufficient number of similarly advantageous forms could never arise at the same time, natural selection would never occur.

Timiriazev criticised this idea that superiority depended on numbers. He accused Danilevsky of misunderstanding the meaning of the struggle for survival by comparing it to a battle between two armies. In reality, Timiriazev said, it was not like that at all. A useful variety did not mean that that individual would kill directly (as in an army) all the other individuals; it just meant that that individual would have a better chance of survival with respect to the surrounding conditions.[36]

Other criticisms of Darwinism listed by Danilevsky in his conclusions were raised in the polemic between Strakhov and Timiriazev, but in general the debate was of an inconclusive kind.

Scientifically there was no question of Darwinism not being the victor. Danilevsky had set himself the aim of disproving the theory of evolution by overthrowing the concept of natural selection. However, he had done this by using facts put forward by other scientists that countered or limited the role of natural selection in the evolutionary process but by no means disproved evolution itself. In Strakhov's arguments there was little mention of evolution. He emphasised the need to disprove natural selection and overthrow Darwinism. His method was to assume that natural selection was the one and only factor allowed for by Darwinists in the process of evolution and that if any other factor such as crossing, the influence of environment, isolation etc. was admitted to being an important part of the process, then the whole of Darwin's argument would fall down. This distortion of Darwin and this method of argument meant that the scientific criticisms, used by Danilevsky and Strakhov and culled from many sources, tended to lose their scientific validity. They both emphasised that no process as complicated as that of the origin of the species and the organic world could be based on a principle of pure chance such as Darwinism. This was a feeling common to many scientists, who thus tried to solve the problem by introducing orthogenetic principles into the evolutionary process. Danilevsky was unable to take this attitude since he believed in the fixity of the species as an act of faith.* Strakhov's beliefs are slightly less clear. In 1862 he had welcomed the Origin of Species as an attempt to explain scientifically the mutability of the species. However, at the same time he had pointed out clearly the limitations of the methods of the natural sciences with regard to human phenomena. Consequently as Darwinism became identified with materialism and with the derivation of man from the ape, Strakhov drew further away. In his polemic on behalf of Danilevsky he was bound by the limits of his friend's arguments[37] and so he too made no attempt to put forward any alternative factor to take the place of natural selection in the process of evolution.

The significance of this polemic did not lie so much in the scientific issues raised as in its cultural aspects which will be examined in more detail in the next chapter. However, perhaps its main scientific significance was the demonstration of the general paucity of genuine scientific opposition to either the theory of

*In the introduction to his book he made two definite points: 1. that Darwinism was as much a philosophy as a scientific theory, and 2. that when he, Danilevsky, first became interested in the origin of species, he had studied Lamarck's ideas but had decided that the fixity of the species was an indisputable fact to be accepted in the face of all rational opposition.

evolution or the concept of natural selection in Russia. Although Danilevsky was a scientist none of his criticisms were original* and after his death it was not a scientist who championed his views but a literary critic with a certain scientific background. The most important other scientist to oppose both the theory of evolution and the concept of natural selection in public was Von Baer, but he died ten years before this polemic took place. A comparison of the ideas of Von Baer and those of Timiriazev, the chief protagonist on the side of Darwin, gives a further understanding of the character and quality of the attitudes of Russian scientists to Darwinian concepts.

Timiriazev played the same role in Russia that Huxley and Gray played respectively in England and America. Between 1864 and 1920 he wrote 28 articles and essays on subjects concerning the theory of evolution, some of which appeared in many editions.(38) From the beginning

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*In fact there is a certain irony here since Danilevsky, in so far as scientific criticism was concerned, was prepared to rely on western science, although one of his reasons for wishing to overthrow Darwinism was because Darwin was a representative of western knowledge and culture. (see p. 301)

he was a champion rather than a critic of Darwinian concepts, and he felt that the bulk of Darwin's scientific work written after the publication of the Origin of Species was "either the development of the basic principles of the theory of natural selection, or the confirmation of its applicability using wide, carefully worked out examples to explain the most complicated and confused biological questions."(39)

For Timiriazev natural selection was the chief factor in the process of evolution and any other factors were of secondary importance. As we have seen in considering the public polemic over Danilevsky's book he felt, like Darwin, that the problem of blending inheritance could be met by allowing for the simultaneous appearance of a number of individuals with similar favourable characteristics, a situation which he felt was quite possible since variability might be caused by the influence of the environment, by crossing or by the living habits of the individual.(40) Timiriazev, however, did not feel it was necessary for Darwin to explain the causes of variability in order to vindicate his doctrine of natural selection. The fact of the existence of variability was enough. To find out actual causes of variability was, in his view, the job of experimental physiology.(41) Neither did he feel the need, as Darwin had done, to try to vindicate natural selection by proposing a hypothesis on heredity. In fact Timiriazev did not accept Darwin's theory of pangenesis.(42)

After 1900 and the new discoveries in the field of heredity Timiriazev welcomed Mendel's laws and the work of de Vries. He felt that Mendel's contribution was very important for Darwin's theory of natural selection since it helped to overthrow one of the most persistent difficulties of the theory - the swamping effect of blending inheritance. However, he felt that Mendel's contribution, although very real, was a limited one to the field of heredity since it by no means explained all the phenomena of inheritance known to scientists. The tremendous support for Mendelism in opposition to Darwinism was, he thought, a result of growing clericalism in England and nationalism in Germany.(43)

Timiriazev thought that the problems which Darwin had primarily set himself and which he had succeeded in explaining, using the theory of natural selection, were firstly the historical development of organismsand secondly their apparently purposive adaptation to their surroundings and way of life.(44) He felt that this perfecting of organisms came from the combined effect of infinite productivity and merciless criticism, in other words natural selection, a process which he sometimes compared to that of the creation of a great work of art, music or literature.(45) This analogy does not, however, seem a very suitable representation of his views since the creation of a work of art depends more on mutations than on an infinite number of small variations.

Despite his stress on the role of natural selection, Timiriazev had a certain respect for some of Lamarck's ideas. He thought that the process Lamarck had attributed to animals, the inheritance of characteristics acquired through use, disuse or the will of the animal, was nonsense and had been firmly overthrown, and he was equally opposed to the ideas of the neo-Lamarckians in this respect.(46) However in the case of plants, which had no will to exercise their muscles, Lamarck had pointed to the influence of the surroundings and this, Timiriazev felt, was a strictly scientific view which had led to fruitful research in the field of experimental morphology. He thought there had been a tremendous confusion over the two concepts. The former, the inheritance of characteristics acquired by exercise, effort and use, had no scientific basis at all; whereas the latter, the concept of the inheritance of acquired characteristics, by which it appears that Timiriazev had in mind the inheritance of the infinite number of variations and mutations that occur in the organic world under the influence of the environment, was a theory still being hotly discussed and had by no means been proved to be scientifically invalid.

Thus we find that Timiriazev, the chief champion and spokesman for Darwin's ideas in Russia, represented a rather moderate outlook. While unwaveringly supporting the concept of natural selection he acknowledged the difficulties confronting it, the contributions that other scientists had made to the theory and other factors that had been shown to be important in the evolutionary process, but he never felt the need to abandon natural selection as the primary factor of evolution, just as he never embraced that concept completely to the exclusion of all others. In fact Timiriazev occupied a position very close to that of Darwin at the end of his life.

If Timiriazev represented the most fervent pro-Darwinian attitudes among Russian scientists then it was perhaps Von Baer who personified the extent of the articulate opposition.

The work of Von Baer on the early embryonic development of mammals, his ideas on transformism and the geographical distribution of animals have already been discussed together with their significance for the theory of evolution and Darwin's acknowledgement of that significance.(48)

In 1860 Von Baer wrote to Huxley expressing his agreement with Darwin's theory and Huxley wrote to Darwin informing him of this good news on August 6th, 1860:-

2 "My dear Darwin,

I have to announce a new and great ally for you . . . Von Baer writes to me thus:- 'Et outre cela, je trouve que vous écrivez encore des rédactions. Vous avez écrit sur l'ouvrage de M. Darwin une critique dont je n'ai trouvé que des débris dans un journal allemand. J'ai oublié le nom terrible du journal anglais dans lequel se trouve votre récension. En tout cas aussi je ne peux pas trouver de journal ici. Comme je m'intéresse beaucoup les idées de M. Darwin sur les-quelles j'ai parlé publiquement et sur les-quelles je ferai peut-être imprimer quelque chose - vous m'obligeriez infiniment si vous pourriez me faire parvenir ce que vous avez écrit sur ces idées.

J'ai énoncé les mêmes idées sur la transformation des types ou origine d'espèces que M. Darwin. Mais c'est seulement sur la géographie zoologique que je m'appuie. Vous trouverez dans le dernier chapitre du traité 'Ueber Papuas und Alfuren' que j'en parle très décidément sans savoir que M. Darwin s'occupait de cet objet.'

The treatise to which Von Baer refers he gave me when over here, but I have not been able to lay hands on it since this letter reached me 2 days ago. When I find it I will let you know what there is in it.

Ever yours faithfully,
T.H.Huxley."(49)

Thus in 1860 Von Baer could be counted among one of the supporters of Darwin. Knowing his previous work on comparative embryology which was a definitive stepping stone towards the theory of evolution, and knowing his previous views on transformism, this did not seem surprising. However when eventually in 1876 the article on Darwinism he promised in the letter above was published, his attitude was no longer welcoming. There was no obvious reason for this, but various pointers show that he modified his ideas very soon after he wrote this letter to Huxley, or perhaps he had never meant to imply acceptance of a total evolution of the species including man. In 1866 he was referred to by Nozhin as one of the Academicians who refused to recognize Darwin's theory.[50] In his own autobiography Von Baer shows that he understood evolution only in a limited sense and he did not share Darwin's views on the primary importance of the struggle for survival and survival of the fittest. He laid more stress on the influence of the environment on the variations in organisms.[51] Von Baer was also generally more sympathetic to Kolliker's theory of evolution by means of mutative jumps.[52] In 1873 he had come out in public against Kovalevsky's contention that the embryonic form of the ascidian was similar to that of the amphioxus, and that it illustrated a possible link between the vertebrate and non-vertebrate kingdoms.[53]

Von Baer's lengthy critique of Darwinism was eventually published in the second volume of his _Lectures_ in 1876, the year of his death at the age of 84 years. It had been delayed for several years. In the first volume of his _Lectures_, published in 1864, he mentioned Darwin's

'Hypothesis', as he insisted on calling it, and proposed to discuss it and the question of why it had been received with such enthusiasm in an essay intended for the second volume.(54) In 1873 the third volume appeared before the second. Von Baer explained in it the reason for the delay:-

> "The second volume was begun quite a few years ago. . . and, in addition to an essay previously published only in Russian on the influence of the geographical environment on the historical development of mankind, it contained also the beginning of an essay on objective and purpose in nature as an introduction to a critique of the Darwinian hypothesis concerning the development of individual animal forms from one another.
>
> "I interrupted this critique of Darwinism, which in draft was already fairly lengthy, when I read the announcement that Darwin would explain the origin of man in accordance with the same principles which he had sought to establish as valid for the origin of other animals. My essay however was directed to showing that Darwin's hypothesis could lay claim to general validity only if the same method of origin could be shown to have plausibility in the case of man also, a question which Darwin had previously avoided entering into. While waiting for the appearance of the book which had been announced I set about working out the essays which will be found in this volume."(55)

From this passage it is clear that the vital question for Von Baer was the application of Darwin's theory to man. What he does not make clear is whether he felt it would carry more weight if successfully applied to man or whether man should be left in a separate category. When the second volume eventually appeared in 1876 Von Baer limited the action of transformation to closely related groups only and denied the possibility of evolution by means of minute variations.

The extent and nature of the differences between the ideas of Timiriazev and those of Von Baer give a very good illustration of the character and quality of the attitudes of Russian scientists to the concept of natural selection. There was a lack of any extreme schools of thought; each scientist adopted his own individual critical or non-critical view point. However, at the same time certain tendencies and trends in attitudes were present.

The three basic ideas of natural selection were heredity, variability and the struggle for survival. There seems to have been little theoretical concern in Russia over the problem of heredity. A long article written for the Russian encyclopaedia in 1897 on heredity(56) outlined the various theories of Darwin, Nägeli, Weismann, de Fries, Spencer and others, but concluded by saying that so far no really satisfactory hypothesis explaining heredity had been put forward. Weismann was criticised by Menzbir in an article written in 1900(57) for trying to fit the facts to his theory rather than his theory to the facts. If anything the Russian scientists leaned to the side of the inheritance of acquired characteristics, not in the pure Lamarckian sense involving the will and purpose of the organism, but in the sense that variations brought about by a changing environment were inheritable.* However, they did not put forward any hypothesis to try and explain how such a process could actually take place.

On the other hand the actual question of the influence of the environment on the organism was emphasised by

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*For example Menzbir considered Lamarck's theory to be of great historical significance. He felt that the casual attitude with which it had been met was not the result of the intrinsic merits or faults of the theory, but a result of the fact that it had appeared at a bad time and had had to contest with a lot of myths. (see "Istoricheskii ocherk na prirodu", p.77.)

many Russian scientists who in their turn often criticised Darwin for not paying more attention to this factor.

A.N.Beketov, the professor of plant morphology at St. Petersburg university, felt that the form of plants depended largely on their surroundings. In an article, briefly mentioned in Chapter III, written in 1860 before Darwin's ideas were known in Russia, he had said that the organism was moulded by its surroundings.(58) After 1860 he developed these ideas in various papers on the influence of light and climate on plant forms. Beketov basically believed that the changing environment was the main reason for varied form in plants:-

> "Contemporary biologists consider the influence of the environment [as] the primary cause of change and the basic reason for the successive development of variations. Inner causes are thought to be characteristics acquired by heredity in a far off generation when they also arose under the influence of the environment."(59)

Beketov was known as a firm supporter of Darwinism,(60) but this presumably meant 'evolution', in the loose sense, since he considered the two chief factors of evolution to be the ability of a given organic form to change, adapting itself to the environment and its ability to pass on by heredity these acquired characteristics. According to him the theory of the origin of species by means of selection could be considered a theory of gradual adaptation of organic forms to the environment by means of their gradual changes.(61) In other words, selection was relegated to a rather secondary position since the organism already had the ability to adapt to the surroundings.

A perhaps more subtle approach was that of Mechnikov. In the unpublished review he wrote in 1863 as noted earlier he had criticised Darwin for attaching too much significance to the factors of natural selection and extinction and he said that these faults arose from a too shallow observation of the influence of the environment on the organism which he felt was the chief fact of the organisation of life. However, ten years later in 1873 he criticised the reigning theory concerning the process of evolution, a process which he characterised in the following words:-

> "The theory of the transformation of the species, in the form given to it by contemporary naturalists, is based on the influence of the environment on

> organisms. All characteristics of the latter are considered to be the results of either direct or indirect adaptation to surrounding conditions."(62)

It is interesting that he should have described the reigning interpretation of the evolutionary process in this way and it perhaps shows the predominant tendencies among Russian scientists. Mechnikov based his criticisms of this emphasis on the influence of the environment on the fact that some organisms developed differently although they existed in an identical environment, while others changed hardly at all although they were placed in very different environments.(63)

This criticism seems to have been limited in its aim rather than total. Mechnikov was objecting to the over-emphasis on direct adaptation to the surrounding conditions but he was not discussing in toto the factor of the influence of the environment. Only three years later in 1876 in a discussion on sexual selection he regretted that Darwin had never considered the influence of the conditions of life on the characteristics of the two sexes, and that he had in fact practically ignored the whole question of the direct influence of the environment on the formation of organisms.(64) Mechnikov for an example of the former pointed to the work of Weismann which had shown that the colour of a certain butterfly had altered with a change in the surrounding temperature.(65) Many years later in a collection of essays in honour of Darwin, Mechnikov writing on 'Darwinism and Medècine' pointed out the useful contribution that medicine had made to the problem of inheritance of acquired characteristics. He described how at the height of the discussion over this question, when it seemed that Weismann had proved its impossibility, Pasteur and two of his helpers found a very typical example of the inheritance of acquired characteristics. A bacillus of Siberian plague reared in unusual circumstances lost its ability to produce spores. This characteristic was passed on through an unlimited number of generations reared in normal circumstances. In this way a new variety arose distinguished both by an absence of spores and by the fact that instead of infecting an organism with plague it protected it from infection.(66)

The point obviously to be noticed in these examples given by Mechnikov is that he did not think that the influence of the environment necessarily directly helped the adaptation of the organism to its surroundings. In the examples he described, the changed conditions of life resulted in an inheritable change in the organism, a type of variation which, as far as could be seen, had no direct connection with the actual quality of change in the environment and so presumably could either be favourable or unfavourable to the organism in its struggle for life. Mechnikov, in opposition to Beketov, did not believe that the organism necessarily adapted to the changing surroundings though it was affected in some way by such changes.

Many other Russian scientists put a similar emphasis on the influence of the environment on organisms, though not necessarily in direct connection with problems of evolution. One example was the school of physiologists whose head, Sechenov, wrote the following in 1861:-

> "You have very probably heard or read at some time that by the word organism is understood a body containing within itself the conditions for its continued existence in its present form. That idea is false and harmful. An organism without outside conditions to support its existence is unthinkable; therefore within the scientific definition of an organism there must be contained the idea of the surroundings which have an influence on it. As the existence of the organism

> is impossible without the latter that quarrel over which is more important to life - the surroundings or the body - does not have the slightest point."(67)

Actual experiments on the influence of the environment were also carried out in Russia. V.I.Shmankevich of Odessa university experimented with a small shrimp (Artemia Salina) which lived in the Black Sea. He developed succeeding generations in both increasingly salty water and decreasingly salty water. When the content of salt was increased a form identical to another species, Artemia Mühlhauseni was developed. With a decreased salt content a form very similar to Branchippus appeared.(68) These experiments on the relation of environment to form were published and generally recognised.

Other, perhaps more significant, experiments being carried out at this time were those of Ivan Michurin, whose ideas achieved notoriety later when they were used by Lysenko as a basis for his biological theories. Michurin, who was a struggling plant grower and experimental horticulturist until the 1917 revolution swept him out of obscurity and into fame, was born in 1855. After a short spell as a clerk on the railways in the 1870s, he devoted himself entirely to his scientific work on his small plots of land. He developed a method of acclimatisation of plants and trees by crossing different species from distant habitats and growing them from seed.

> "Under this method the chosen pairs of parent plants were placed, in our part of the country, in an environment to which they were unaccustomed. The offspring of such cross-breeds were most adaptable to our climatic conditions and produced a more favourable combination of qualities, one that approximated the requirements I had set. As a result of such hybridisation, the southern plants transmitted to their offspring flavour, size, colour etc., while the wild frost resistant species contributed their endurance to our severe winter frosts."(69)

Michurin explained why this method of acclimitisation was successful in the following way:-

> "Every plant has the faculty of altering its constitution, adapting itself in the early stages of its life to new environmental conditions. But this faculty manifests itself in greatest degree in the first few days after germination; then it diminishes; and after the first 2,3 or occasionally 5 years of fruiting, it gradually disappears. Thereafter the newly obtained variety becomes so resistant to change in the direction of greater hardiness that any methods of acclimitisation are practically out of the question."(70)

These ideas were closest to those of Beketov or Lamarck since they recognised a limited ability of the plant to adapt to changed surroundings in its early stages, though at the same time Michurin encouraged the appropriate adaptation by providing the necessary characteristics in the crossed parents.

Michurin's experiments were not given much practical government help or recognition in Russia prior to the 1917 revolution. A few articles by him appeared in gardening reviews in the early 20th century. However, his work was recognised abroad. In 1908, in a letter he wrote to his own Ministry of Agriculture, Michurin stated that he had been in contact with other Ministries from abroad, especially in America, for the last fifteen years, while the Russian government had ignored his work. In 1913 the American Agricultural Department asked him to sell them his whole collection of plants but he refused.(71) In essence his practical work on selection reflected the theoretical interest in the influence of the environment present in the universities.

In addition to this emphasis on the influence of the environment in the formation of variations other ideas existed in Russia. It has already been mentioned that Von Baer was sympathetic to the theory of heterogenesis proposed by Kölliker in 1864 as an alternative to natural selection, though in general, in the 1860s, Kölliker's thesis was not very convincing and few people took much notice of it. However, at the end of the century, a young Russian botanist and Academician, named S.I.Korzhinsky, developed the theory of heterogenesis in a lecture he gave to the physical and mathematical branch of the Academy of Sciences on January 20th 1899. The lecture was called 'Heterogenesis and Evolution' and was published in the Memoires of the Academy. Korzhinsky described the aim of this lecture as the characterisation of heterogenesis as a phenomenon.(72) He hoped later to present work on the role of heterogenesis in evolution but it appears that he did not succeed in doing this since he died just a year later in 1900 when only 39 years old.

Despite this fact his ideas are fairly clear:-

> "With regard to cultivated plants at least I can quite safely maintain that no cultivator has ever obtained a new race by using individual characteristics and that the 'accumulation' of the latter has never been observed. But all new varieties

> (except for hybrids) whose origins we know, have in actual fact arisen by means of sudden deviations from the pure species or hybrid form."(73)

Korzhinsky asked himself whether these sudden variations did not play a similar role in nature to that which they played with cultivated plants. In his lecture he tried to prove that heterogenesis was a perfectly normal phenomena in both plants and animals and that it played a large role in their evolution. He went carefully through the various parts of the plant - stalk, leaves, petals etc. - where heterogenesis could and did occur, and he gave examples that he himself had observed or which he had culled from extensive reading of gardener's journals and similar magazines.

Korzhinsky defined heterogenesis as the sudden appearance of a single individual which was outside the norm of the species and which had certain hereditary characteristics; within each species it was a fairly rare phenomenon but in general occured regularly; because of the fact that the new characteristics were usually very stable through heredity, they were preserved in future generations thus giving rise to a new variation and eventually a new species. He acknowledged that he did not know the cause of heterogenetic variations but he was careful to distinguish them from modifications resulting from the influence of the environment and from hybrids. He certainly felt that mutations themselves could not be the direct result of the environment since only one mutation occured among many individual organisms all living in the same conditions and he thought the cause to lie within the organism. With regard to heredity Korshinsky pointed out that heterogenous variations tended to be very stable even to the extent of not being able to cross with their parent form, and this he suggested could be the result of physiological changes occurring in the reproductive system at the time of the formation of the mutation. Korshinsky contrasted heredity and variability as two antagonistic tendencies present in the organism. In normal conditions heredity dominated but over a number of generations the tendency to vary stored up enough energy to predominate and produce a heterogenous variation.(74)

Timiriazev was very critical of Korshinsky's ideas, partly on political grounds it seems.(75) One scientific point he made, however, was that Korshinsky had taken many of his examples of heterogenesis from Darwin without acknowledgement.(76) This may be true but did not invalidate Korshinsky's attempt to assign to heterogenesis a more significant role in evolution than Darwin ever gave to the phenomenon. Darwin knew of the existence of heterogenesis but felt that the majority of such sudden variations could be explained by atavism or teratology. Out of the abrupt variations that remained he felt that in nature they would occur so rarely that they would be immediately swamped by blending inheritance. Such variations could be used among domesticated races but only with the careful help of man.(77) Korshinsky knew of this opinion of Darwin; his aim was to prove it wrong. However he did not live long enough to complete his own work or to learn of the discoveries on heredity of Mendel, de Vries and others.

The third idea necessary for the concept of natural selection was the struggle for survival. There was a definite tendency among certain Russian scientists to reject or at least modify this idea. A young embryologist, Nikolai Noshin, criticised Darwin in 1866, saying:-

> ". . . in talking about 'the link between the struggle for survival and natural selection' it seems Darwin does not notice that the whole link here is limited to one antagonism of these two conditions of development, and therefore of course

does not see that the struggle for survival is harmful to development . . ."(78)

He criticised Darwin for the use of Malthus's theory and put forward his own concept of how progress and development were achieved:-

"This law can be expressed in the following way: two completely similar organisms do not struggle against each other for existence, but on the contrary, aspire to merge together, that is to say to join together their homogenous strengths, their interests, and thus instead of the division of labour we see only collaboration in their relationship."(79)

Nozhin did admit that a struggle for existence existed among animals but he felt that there was absolutely nothing creative in it.

This reasoning was not exceptional. In Russia there existed a whole school of sociology built round the idea of mutual help rather than struggle.(80) Neither were the ideas limited to non-scientists. The most famous representative of the sociological trend, Prince Kropotkin, was a scientist in his own right. He had been given the idea of the law of mutual aid by a zoologist, Professor Kessler of St. Petersburg university, in a lecture to the Russian Congress of Naturalists in 1880, and he quotes Kessler as saying "that besides the law of Mutual Struggle there is in Nature the law of Mutual Aid, which for the success of the struggle for life, and especially for the progressive evolution of the species is far more important than the law of mutual contest."(81)

Timiriazev, while not rejecting the fact of the struggle for existence among animals, was careful to point out its limitations with regard to man and he strongly criticised those followers and translators of Darwin who crudely applied the struggle to man. He felt that Darwin could never have meant such a thing:-

> ". . . surely he Darwin whose every word breathes of the highest humanism could not start to propagate the ideals of cannibalism? Surely he, who even in relation to the improvement of an animal breed points to the speed and superiority of the results of unconscious selection, would not start to prove the superiority of an elemental struggle over the conscious progress of mankind. Of course he has pointed out the results achieved during countless centuries of unconscious competition between living beings, but it does not follow from that that man must turn away from any conscious action that is directed towards the achievement of 'the greatest good for the greatest number.'"(82)

Timiriazev then went on to say that in man the social instinct is second only to that of self-preservation:-

"Darwin adheres to the basic idea that moral feeling to a certain degree hereditary, appeared in the form of an instinct and gradually was transformed into conscious feeling. This instinct was the <u>social instinct</u>, the aspiration to social life which is so deeply rooted in man's nature."(83)

The problem facing Timiriazev, Kessler, Kropotkin and other scientists with similar views (84) regarding the struggle for survival was that such an idea contradicted their own conceptions of morality and progress.(85) Some like Kropotkin rejected the very existence of such a struggle, others like Timiriazev recognised the relevance of the struggle in the animal and plant kingdoms but tried to limit its application to man. They all attempted to pose as an alternative factor the idea of progress or development through the mutual aid or solidarity of organisms, a generally subjective concept although it did have a certain factual basis.

There were, of course, other scientists who criticised the Darwinian concept of the struggle for survival without necessarily posing specific alternatives. One of these was Mechnikov who discussed the problem in great detail in a number of articles.(86) His main contention was that the factor of the struggle for survival was much more complicated and difficult to understand than was generally admitted. There were a number of scientific difficulties. Firstly, Darwin had derived his concept from Malthus's theory which stated that the cause of the struggle was the fact that the population increased geometrically while the food only increased arithmetically. Mechnikov acknowledged this as a limited truth, but pointed out the paradox that at the same time high reproductivity could also be an advantageous weapon in the struggle. The second difficulty was the problem of the strength of the winning organisms in the battle. The winner was termed the best adapted to the given conditions, but Mechnikov pointed out that many botanists had noticed that different species seem to give way to each other in succession without any apparent reason and he quoted from de Candolle and Nägeli in support of the view that the strength of a species must lie in hidden physiological characters and not in the morphological characteristics used for systematisation. Closely connected with the question of strength was that of progress. Darwin had seen the perfection of the organism as one of the main results of natural selection and he defined this progress or perfection by the degree of isolation of the different parts in the adult form of the organism and by the degree of the specialisation of those parts. Mechnikov found this idea very unsatisfactory for a number of reasons. For example, many characteristics of organisms, like the colours of flowers and animals, which might or might not have played a role in the struggle for survival, could in no way be termed progressive. In general he felt that there was no necessary link between progress and natural selection as Darwin had suggested but at the same time he rejected the attempts made by some scientists to explain progress by the innate striving of the organism for perfection. While acknowledging that a general law of progress did exist Mechnikov pointed out that it by no means developed in a straight line, that regress was almost as common as progress and that the most widespread element in nature was conservatism. To take the place of the idea of a general law of progress resulting from the struggle for survival he put forward instead the idea of a general law of development which could cover a wide number of phenomena such as progress, regress, conservatism and simple regrouping of parts. Another interesting point that Mechnikov made with regard to the struggle for survival was that the victory of any given organism did not only depend on its own qualities but also on the conditions of the environment in which it took place. With regard to man Mechnikov acknowledged the existence of a struggle, both between individuals and between groups, but again he pointed out the complication of the situation especially as the demands of ethics generally appeared to be in opposition to the necessary prerequisites for victory in the battle. The struggle itself was not purely the result of over-population but was also caused by human aspirations and needs that could only be satisfied to a limited degree. Mechnikov did not accept Malthus's solution to over-population believing that the answer to that problem lay in artificial methods preventing fertilisation.

In their attitudes to the three basic ideas of natural selection - heredity, variability and struggle for existence - it is Mechnikov who stands out as the most original and serious critic among Russian scientists. M.A.Antonovich, a contemporary commentator, felt that his reservations with regard to Darwinism might have been the result of his hostility to the ideas of Haeckel, the chief propagandist of Darwinism in Germany.(87) Haeckel had converted Von Baer's laws of embryonic resemblance into the Biogenetic Law of theory of recapitulation. This stated that the embryonic stages through which an animal passed in its development represented the successive adult stages through which its ancestors had evolved.[88] It also presumed that the events of embryology were mechanically caused by those of evolution, although there was no critical evidence to support this hypothesis.[89] Very early in his own career and at the height of Haeckel's popularity, Mechnikov pointed out that although this concept, that ontogeny repeated phyllogeny, was useful it was by no means generally applicable or valid and he criticised Haeckel for his attempt to make it so.[90] This criticism was certainly scientifically valid though Mechnikov may have also been prompted into his criticism of Haeckel for the personal reason that he thought that everything of scientific value in Haeckel's theories came from the original work of other scientists and especially from Mechnikov's friend, Alexander Kovalevsky.*

*Mechnikov felt that Kovalevsky had a much more scientific approach than Haeckel. Although Kovalevsky had observed a regularity in the formation of the alimentary canal by invagination of the blastoderm and had drawn a cautious generalisation (p.193), his further work showed that this process was not true of all invertebrates. He regarded Haeckel's Gastraea theory with caution (Haeckel had invented hypothetical stages in evolution, the 'blastaea' and the 'gastraea' which corresponded to the blastula and gastrula stages in embryonic development).

It seems unlikely that Mechnikov's critical attitude to Darwinism was a result of his hostility to Haeckel. In 1863 before Haeckel had put forward his embryonic theories or was widely popular, Mechnikov had expressed certain criticisms of Darwinian concepts. The level and quality of his criticisms in later articles pointed to a mind never satisfied with easy answers and always pointing to the need for further research into problems.

The main characteristic of the attitude of Russian scientists to the concept of natural selection, distinguishing the situation there from that in America and Europe, was the lack of development of any specific schools of criticism. A critical attitude to the concept of natural selection was present in Russia as it was in all other countries for the simple reason that the actual processes underlying natural selection were not scientifically understood. But whereas in other countries the need was felt to put forward alternative hypotheses like neo-Darwinism, neo-Lamarckism, orthogenesis and heterogenesis, in Russia no such schools of thought took firm root* and the most that can be said is that certain

*For example, Timiriazev refers in his writings to a scientist called Polovtsev as being a Neo-Lamarckist. There is no entry for such a Polovtsev in any encyclopedia or biographical dictionary. Papers by a V.V.Polovtsev, who may or may not be the same person, published in the Mémoires of the Academy are not numerous and the ones I have seen were of a non-controversial character.

tendencies can be discerned, for example an emphasis on the influence of the environment on the organism and a dissatisfaction with the idea of the struggle for survival. This may have been the result of the fact that Russian biology was in a period of development; it had no long established traditions behind it and the second half of the nineteenth century was the period when its scientific traditions were being established. Consequently Russian biologists felt no weight of tradition; each man was free to follow his own ideas and inclinations. The fact that the actual theory of evolution as such had been accepted with practically no opposition in Russia may have provided an additional reason, since, with the lack of hostile criticism, Russian scientists, unlike those in other countries, were not forced to defend and consequently closely examine the arguments for and against both evolution and natural selection. They did not have to seek alternatives since there was no strong public challenge at home to the given concepts.

CHAPTER VII

Darwinism and Russian Thought.

The intellectual and cultural situation in Russia in the 19th century has already been outlined briefly in Chapter I, where it was shown that the period from 1860 to 1900 was characterised by a number of factors. Politically it passed from an atmosphere of reform to reaction with the Russo-Turkish war and accompanying extreme nationalism taking place in the late 1870s and 1880s. Intellectually the early 1860s were marked by a strong belief in science and scientific methods accompanied by an extreme nihilism and egotism. Later this gave way to populist ideas emphasising self-sacrifice for the sake of the happiness of others. From the late 1870s to the end of the century the dominance of the so-called materialist ideas of the revolutionary nihilists and populists was generally replaced by more idealist thinkers. Common to all these trends, however, was a belief in the need to change society and to build anew on the co-operative ideals of the peasant commune. The position of the orthodox church throughout this period was one of close identity with the autocracy and lack of intellectual autonomy or integrity. It is within the perspective of these cultural and intellectual trends that the public reception of Darwinian doctrines concerning evolution has to be seen.

Religious and Philosophical Thought.

In Europe and North America some of the most violent public opposition to the theory of evolution came from the side of the church. Bishop Wilberforce's question to Huxley at the Oxford meeting of the British Association is perhaps the most famous example. The situation in Russia was remarkable for the absence of any such open criticism. Thus The Orthodox Review, the most popular and lively of the theological reviews, had no mention at all of the Origin of Species, Darwin or the theory of evolution in its numbers published during the 1860s,[1] and there is no reference to direct criticism or comment on the theory in any other theological review of this period.[2]

Of course, as was mentioned in Chapter I, the orthodox church did not have a strong independent intellectual tradition of comment on secular matters, such as existed in the Catholic and Protestant churches of western Europe and America. This resulted from the fact that the Russian intellectuals, alienated from the church because of its close association with government policies, had generally rejected formal orthodoxy; in addition the priests, being a hereditary class, were often of a very low intellectual level. However, there did exist at the beginning of the 1860s one source of articulate intellectual orthodoxy, which had developed as a result of the growth of universities and education. This was the professors and lecturers in theology at the universities, seminaries and theological institutes; although they seem to have taken no direct interest in the theory of evolution as such, they did show concern over problems such as man's place in nature, his relationship to animals and to God, problems which were raised in western Europe and America in connection with Darwin's theory of evolution.

In 1860 an article appeared in the <u>Orthodox Review</u> called 'On the primary origin of the human genus on earth' and written by V.Kudriavtsev.(3) The author set out to investigate the possible origin of man. He rejected as fantastic the theory that man could have originated spontaneously out of inorganic matter as some of the German naturphilosophers suggested. He discussed in more detail the question of the progressive development of organisms and the theory that man originated from the apes. After mentioning the ideas of various scientists such as Linnaeus, Lamarck and Erasmus Darwin, Kudriavtsev came down heavily on the side of Cuvier, Agassiz and the ideas of the catastrophists. Man had been specially created; final proof lay in the fact that man was distinguished from animals by his language, social behaviour, art, religion and ability to continually perfect himself. This was the only article to appear on the subject in the Orthodox Review during the 1860s,[4] but a similar point was made in an article published in the Russian Herald on 'The Natural History of Man' by the French naturalist Quatrefages.[5] He treated man as being subject to the same laws as plants and animals, but like Kudriavtsev, saw an essential distinction between man and animals. For Quatrefages the special features of man were his morality and religious feeling. The same point was made by the editor of the Russian Herald,[6] and again by N.N.Strakhov in the review he wrote of the Origin of Species, where he warned that despite the fact that man may have evolved from animals physically, it must not be forgotten that man was still distinguished from animals by his moral qualities.[7] In the 1870s a number of articles on similar themes appeared in the Orthodox Review including a comment on the Russian translation of Wallace's Contributions to the Theory of Natural Selection.[8] This book had first been translated by a Professor Lindeman[9] who had left out all Wallace's references to the limitations of natural selection with regard to the development of certain intellectual and psychological qualities of man. Then the zoologist, N.P.Wagner, protested against this doctored version and made a new translation although he himself was not in agreement with Wallace on this question. The writer of the article in the Orthodox Review was grateful to Wagner for doing this and he went on to discuss Wallace's ideas on the limitations of natural selection. This article perhaps came as near to direct comment on the theory of evolution as any in the Orthodox Review.

The articles mentioned above did not form part of any great moral or religious debate, but that does not signify that there was a total absence of polemic between the church and the new ideas of the then rapidly developing natural sciences.

In 1860 P.D.Yurkevich, then professor of theology at Kiev, attacked Chernyshevsky for his article 'The Anthropological Principal in Philosophy'.(10) The question under discussion was that of the duality of knowledge, the relationship and origin of psychological and physiological phenomena, of moral and sensual feeling.

Chernyshevsky had maintained the unity of man's knowledge:-

> "The idea of the unity of the human organism, as it has been worked out by the natural sciences, serves as the principal basis of the philosophical outlook on man's life in all its aspects; the observations of physiologists, zoologists and doctors abolish any idea of dualism of man. Philosophy sees in man what medicine, physiology and chemistry see in him. These sciences prove that in man no dualism is discoverable; but philosophy adds that if man had a second nature in addition to his real (material) nature, the second nature would necessarily manifest itself, in some way. But since no such second nature displays itself, since all human conduct and all human manifestations conform solely to his real (material) nature, it follows that he has no second nature."(11)

Chernyshevsky explained the unity between material and moral phenomena, i.e. between physiological and psychological phenomena, by an analogy with the three states of water:-

> ". . . a quantitative difference is transformed into a qualitative difference . . ."(12)

Chernyshevsky's was very much common sense materialism; it was an attempt to abolish any unknown vital phenomena that could not be explained by man's knowledge, to rid man of moral ideas that could be used to bind him. The arguments were not always very consistent or logical, and when using the ideas of the German materialists like Moleschott,(13) sometimes became extreme to the point of ridicule.

Professor Yurkevich published his criticism in the Transactions of the Kiev Theological Academy; his article was called 'From the Science of Man's Soul'. At first it was generally ignored; the Transactions cannot have had a wide public appeal or circulation. Then the most influential conservative review the Russian Herald took the matter up and published large extracts from the article in their April and May issues of 1861.

Professor Yurkevich's argument was reasonable and well set out. He countered Chernyshevsky's arguments about the unity of the human organism by pointing out that however much you tried you could not escape the fact that there were two aspects to human beings: the external body and the inner feelings. In the first case we could have a physiological understanding of man's body; in the second case we had a psychological understanding of man's soul. Physiologists could not observe thought because it had no weight, form or temperature. They could observe the movements of the nerves that corresponded to various sensations but these observable movements were not the sensations themselves. The main point was that physiological methods would not solve metaphysical problems, and Yurkevich maintained that there had to be different methods for problems of the external and internal worlds.(14) He criticised Chernyshevsky for saying that since there was no essential difference between consciousness and self-consciousness, there was no essential difference between man and animals. Yurkevich maintained that there were two forms of self-consciousness which man possessed and animals didn't: firstly, there was the critical relation of the soul to its own <u>empirical</u> position, a relationship which conditioned the development of man through ideas;

secondly, there was the knowledge of "the ego" as the basis of spiritual phenomena.(15)

In a review(16) of G.H.Lewes's book Physiology of Common Life, which was translated into Russian in 1861, Yurkevich developed his ideas but rather broke the strength of his argument. In criticising Lewes's idea that sensations existed in space and time and could be measured if one had the right instruments and knew where to look, Yurkevich put forward the idea that there existed in the body apart from its main organs a basic mass of undifferentiated cells which were the seeds of psychology. Here he seemed to be trying to find a physiological answer to the problem by searching for a material substrate for psychological sensations; in fact by doing this Yurkevich admitted the strength of Chernyshevsky's or the materialists' arguments. He was not, however, sure of himself and later on said that the whole problem was very complicated and needed further study.(17)

The polemic did not continue beyond this point as Chernyshevsky refused to answer Yurkevich's article. Chernyshevsky wrote in the July issue (1861) of the review he edited, Contemporary, that he had no intention of even reading Yurkevich's article as he knew the arguments already. Since he was the son of a priest and had gone to a theological seminary, where he had been instructed in the arguments that the theologians used against materialist philosophers such as Aristotle and Bacon, he did not feel that Yurkevich could have anything to say to him that he had not heard already.

Various comments on the debate did appear - in the <u>Orthodox Review</u>, the <u>Russian Herald</u>, <u>Notes of the Fatherland</u> and other contemporary reviews. There was no further direct clash between Yurkevich and Chernyshevsky but a series of direct exchanges between the materialists and idealists continued from that time right up to the 1870s culminating in a debate(18) between Sechenov and the historian Kavelin.(19) It is also possible to see the polemic that took place between Timiriasev and Strakhov in the 1880s as a continuation of the same materialist versus idealist conflict, essentially part of the Russian search for identity mentioned in Chapter I.

If the public attitude to Darwinism is to be understood it has to be seen within the context of the various cross-currents of ideas existing in Russia in the second half of the 19th century.

Throughout that period the theory of evolution and Darwinian concepts were never an issue per se. From the very beginning Darwin's ideas were identified with various shades of revolutionary, progressive and materialist thought.* This was the result of two main factors. Firstly the beginning of the 1860s was a period of government reform and development of science which inspired many intellectuals to believe in the possibility of the progressive re-organisation of society along scientific lines. Secondly the alienation of the intellectual from the orthodox church led him to seek new faiths elsewhere.(20) As a result of these two factors the ideas of Darwin as well as those of Buckle, Spencer, Mill and the German materialists were adopted by the radical intellectuals of the 1860s both as gods

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*In Kolokol, 1 Sept., 1866, it was reported that the Russian authorities ordered bookshops to stop selling Vogt, Darwin, Moleschott and Buckle after a young Russian student, Karakozovsky had attempted to poison his father in 1863 so that he could inherit his father's money for the revolutionary movement. See also p.458 for the connection between the natural sciences and revolutionary student agitation. However, Darwinists do not seem to have been actually persecuted by the government because of revolutionary connotations, as happened in Germany. (See Radl, pp.46-7.)

and guides. Attitudes altered in later periods but Darwinism retained a certain identity with the ideas of materialism and progress right up to the end of the 19th century and later.

Although the Yurkevich-Chernyshevsky polemic took place in 1860-61, before Darwin's theory was well known in Russia, this debate was an important indication of the social climate into which Darwin's theory arrived. The intellectual disadvantages of the orthodox church already mentioned were further increased by the fact that the dominant and fashionable idea in intellectual society at the beginning of the 1860s was materialism. It was the mood in which the reform of society was sought and Chernyshevsky was its representative:-

> "Materialism was for him an article of faith and a political programme, and this is why his Anthropological Principle became the programme of radical youth. Relentless, daring, a sovereign tone, the energy of conviction in the name of science and not in that of any official metaphysic, ensured for Chernyshevsky a literary and political victory in the debates that ensued."(21)

Yurkevich, however much he was able to tear holes in Chernyshevsky's arguments and logic, could not win. He was defending theology and that meant autocracy:

right was on Chernyshevsky's side. It was not a battle of the semantic, but a political battle. Even the <u>Orthodox Review</u> recognised the moral superiority that Chernyshevsky had at the time, though it did not feel that this was because of the inner strength of materialist ideas, but rather the result of the contemporary circumstances.(22)

The theologians generally recognised and admitted the moral superiority of the materialists and the failure of religion at that time. Katkov stated the position in very strong terms in a letter he sent to the Ministry of Education in 1858 advocating the separation of the church from the state:-

> "It is impossible to view without sorrow the growing indifference of Russian thought to the interests of religion. It is the result of trying to separate by force high moral ideas from those of living educated Russian society . . . When it is only possible to repeat formal and stereotyped phrases, one loses one's faith in religious feelings and everyone is involuntarily ashamed to express them; the Russian writer never dares to address the public with the same religious conviction that writers of other countries can adopt . . ."(23)

N.A.Sergeevsky in his address to the students of Moscow university in the ununiversity church at the beginning of the 1860 academic year was hardly cheerful about the situation:-

> "We won't exaggerate the position. Thanks to God, faith has not completely disappeared in this century."(24)

Because of this weak position of official religion the theologians sometimes tried to adapt and use the tools of the enemy in an attempt to move with the times. V.Kudriavtsev in his article on the origin of man said that theologians must learn to use the materialists' own weapon - empiricism. It was no longer possible to say "It is so because God made it so."(25) Yurkevich made the same point at the beginning of his article 'From the Science of Man's Soul' where he said that the present realistic philosophy had made so many discoveries in the sphere of spiritual life that theologians could not afford to ignore it.(26) The use of Wallace's arguments on the limitations of natural selection was a further attempt to gain respectability.(27)

The theologians might have tried to use the tools of the scientists but there were no scientists prepared, either with their tools or without them to defend religion or at least the official representative of religion in Russia, the Orthodox Church. In 1865 the <u>Orthodox Review</u> published a Declaration(28) signed by 210 English scientists who deplored the present anti-religious tendency among scientists and who put forward the word of God as being more reliable than the scientists' own observations, should the two clash. The editor's comment on this declaration was as follows:-

> "For anyone who should read this declaration it serves as a clear example of the following truths, extremely edifying for our society. 1) In England naturalists and scientists are generally not indifferent to theological questions and to the religious oscillations of society; 2) in England scientists not only do not like to pride themselves on differences between science and faith, but even it seems are ashamed of such differences if they are temporary and arise from the enthusiasm and misuse of man's intellect, and they try in all ways to preserve the honour of science from the suspicion of any contradiction with revealed knowledge; 3) in England the genuine natural scientists by no means share those enthusiastic opinions about the perfection of contemporary natural science and in general about the infallibility and universality of the human intellect, which are preached here by certain gentlemen who have just become acquainted with the word 'natural science' and who have two or three Russian translations of popular essays on the

natural sciences."[29]

This comment is very revealing of the situation in Russia and illustrates the extremist tendencies in Russian thought, mentioned in Chapter I. Russian scientists apparently did not feel the need to search for a compromise between the tenets of religion and those of science.

The failure of the church to capture the minds of the Russian intellectuals and its consequent failure to attack and criticise successfully either materialism or darwinism meant that the leadership of the idealist trend was occupied by writers and thinkers like Leontov, Dostoevsky, Tolstoy, Strakhov and Danilevsky, who, though hostile to materialism, were generally also hostile to the orthodox church and did not give much comfort to the representatives of official religion. Despite this fact the actual popularity and influence of these idealist thinkers was closely tied to the fortunes of official religion and the autocracy. With the increasing nationalism and political reaction of the 1870s and 1880s idealist ideas became more dominant but they never seized the imagination of the whole of educated society as materialism had done at the beginning of the 1860s.[30] The proponents of this idealist trend of the 1870s and 1880s can also be seen to be the heirs of the slavophil movement of the 1840s. With the growing political reaction and nationalism the mood of Russian society made another of its swings away from receptivity of western European ideas to a firm belief in the uniqueness of the slavic destiny.* None of the leading thinkers mentioned above, with the exception of Danilevsky, was an orthodox slavophil but they all shared a dissatisfaction with the present way of life in Russia and they looked to religion and faith, rather than to western ideas, as the way to achieve progress.

Within this context of a growing political reaction and a growing nationalism Darwinian concepts, because of their association with the ideas of materialism and as a symbol of western European thought, were regarded with growing suspicion and for the first time the public mood

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*An illustration of the connection between the growing Slavophil-idealist movement and the developing political reaction is given in the following quotation from Strakhov's introduction to Danilevsky's slavophil work Rossiia i Evropa: "The largest demand for the book Rossiia i Evropa was at the height of the Turkish war, when many, influenced by military and patriotic fervour, wish to clarify the relationship of Russia to the Slavs and to Europe." (see Danilevsky, Rossiia i Evropa, p.xxiii.)

was such as to allow for a direct criticism of them.* Even so there was only one leading idealist thinker who made such an attack, Danilevsky, and when he died his friend who took up the cudgels on his behalf did so more for friendship's sake than from any great enthusiasm on his part.+

Both Danilevsky and Strakhov had two important moral reasons for wanting to overthrow Darwinism. Firstly, for them, Darwin's theory was representative of the foreign materialist ideas prevalent in Russia; and secondly, Darwin's ideas were the ideas of a western European and as such were a symbol of Russia's dependence on European intellectual thought. In letters written to Tolstoy, Strakhov referred to both these factors:-

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*Timiriasev wrote: "Patriotic pride is obviously playing a not insignificant role in the exultant reception which this book [Darwinism] met in a certain section of our press." (see Charl's Darvin i ego uchenie, 1898, p.226.)

+In a letter to Tolstoy, Strakhov wrote: ". . . So for more than a year I have spent all my time working for the memory of N.Y.Danilevsky; he is very dear to me but often I am bored with my work . . ." (see Tolstovskii Muzei, pp. 300-1.)

". . . one of my proud dreams was the precise and rigid overthrow of the mechanical outlook and its replacement by another."(31)

". . . it is simply a marvel: if you take it even to mean a protest against our intellectual fawning before Europe - whatever the reason, one cannot help but be glad . . . And Timiriasev and Famintsein accuse Danilevsky quite seriously of <u>disrespect</u> to Darwin. What shameless servility."(32)

Danilevsky himself felt that Darwin's theory had succeeded in Russia because it corresponded to the spirit of the times, a spirit of servility before European ideas:-

"In Russia, where everyone has grown accustomed to thinking in a German way, this [the growth of materialism in Germany] was reflected in an exaggerated manner, as is customary with imitators, by Nihilism . . . which, as all our other evils, is the pure result of our imitativeness and lack of originality.(33)

It was Nihilism that sowed the seed, in Danilevsky's eyes, for the successful reception of Darwinism in Russia.

In his book <u>Darwinism</u> Danilevsky, in addition to discussing in great detail the scientific criticisms of Darwin's theory, gave emphasis also to objections based on his own slavophil interpretation of history:-

> "His [Darwin's] theory is a purely English doctrine; it not only includes all the peculiarities of English thought, but also the characteristics of the English soul. Practical use and competition are the two precepts which direct to a considerable degree not only English life but also English science. The ethics of Bentham, and Spenser too, are based on usefulness and utility; the political theory of Hobbes is based on the idea of the war of all against all, a real battle for survival; the economic theory of Adam Smith, and in general all English political and economic science is based on competition and rivalry. Malthus used the same principle on the problem of population. Even Bacon's philosophy is strictly utilitarian, as Macauley has shown very clearly in his study on Bacon. Darwin has applied the individual theory of Malthus and the general political economic theory to the organic world."(34)

That the theory of natural selection was purely English was further illustrated in his view by the fact that another Englishman, Wallace, had come to the same conclusions.(35) These objections of Danilevsky against the theory of Darwin were derived from his slavophil philosophy. Something that was so clearly a produce of English traditions could not be acceptable in Russia.

On religious grounds Danilevsky rejected the idea that chance could be the basis of a scientific theory explaining the origin of the species. He thought that the origin of species was such an important and complicated phenomenon that it was morally impossible to explain it simply by one general, all embracing law.[36] And in the debate that followed, Strakhov put forward reason in opposition to chance as an essential force in nature:-

> ". . . there is reason in nature, obvious manifestations of an intellectual basis around us . . "For Darwin tried to drive reason from the creation of the world; and if reason is banished then intelligence itself, both God's and our own human intelligence, is eliminated."[37]

No other leading idealist thinkers took part in any public criticism of Darwinism, but their ideas are relevent for their attitudes to science in general.

Vladimir Soloviev, an important philosophical writer, was by no means totally inimical to science. L.M.Lopatin described his views as follows:-

> "He had an unshakeable belief in the imminent conclusion of the historical process. In this he was in agreement with his contemporaries: faith in history, in progress, in the forthcoming and final

> triumph of all cultural ideals over life and in the establishment of an earthly paradise among men, these beliefs were in their own way a kind of religion of the Russian intelligentsia during the second half of the nineteenth century."(39)

Soloviev's beliefs were similar to those of the materialists who were also searching for 'a Heaven' on earth, buth his methods were different. Soloviev felt that man needed faith and revealed religion if he was to achieve progress. At the same time he accepted amny of the conclusions of science regarding the organic connection between man and animals, admitting that the dog and monkey, in their feelings towards their master, display the rudiments of religious sentiment. Soloviev also tried to make a classification of natural beauties based upon physical classifications of the external world. First there was the quiescent world of light - sun, moon, stars, atmosphere etc. Next came nature in motion. Then Soloviev gave an analysis of beauty in organic life: the worm was the archetype of ugliness and living beings were beautiful in proportion as their organism contrasted with that of the worm. Here Soloviev availed himself of modern zoological theories borrowing especially from the ideas of Darwin.(40)

Dostoevsky's attitude to science, however, was hostile as he made quite clear in his Letters from the Underworld written soon after a visit to the Crystal Palace in London:-

> "What have I to do with the laws of Nature, or with arithmetic, when all the time those laws and the formula that twice two make four do not meet with my acceptance?"(41)

Dostoevsky felt that the achievements of science could not solve man's individual dilemma and might reduce him to a new form of slavery. He found his own answer to this problem in faith and salvation through suffering. But Dostoevsky never made the mistake of underestimating the strength of the materialist philosophy. Ivan, in the Brothers Karamazov, put forward extremely strong intellectual arguments against religion. Alyosha could not answer him by reason, only by faith. The two brothers represented the duality that Dostoevsky believed to exist in every man - the tendency to unbelief and atheism and the tendency to belief and faith.

Tolstoy felt that science, like art, was an intellectual luxury carried on at the expense of thousands of hours of peasant labour.(42) He did not have a tremendous respect for the achievements of science either. In a letter he wrote to L.E.Obolensky[43] he agreed that science destroyed harmful superstitions but he did not think that this mattered very much since men's beliefs did not influence their ability to recognise truth or morality. If one man believed in the devil and miracles and another man believed in atoms and ether, the only difference between them was their ages; they could both be equally beautiful and would both maintain that their respective views were right. Tolstoy thought that the big mistake made by members of the Russian intelligentsia was to believe that they were contributing to moral progress by engaging in science. He compared the usefulness of their activity as being on the same level as the work of a baker or lamp-maker.[44] In 1891 Tolstoy made a specific reference to Darwinism in connection with this point.[45] He criticised the botanist, Beketov, for attempting to base morality on Darwin's theory in an article the latter had written entitled 'Science and Morality'; on this occasion Tolstoy put forward the argument that morality and evolution were quite incompatible, since morality was not only useless but always harmful both for the individual and the species.

Common to all these idealist thinkers who reached the peak of their influence in the 1870s and 1880s was the idea that science had little relevance for solving the moral problems of society or for defining the concept of progress. It is interesting to find that in the social sciences, a field which was generally greatly influenced by Darwin's ideas, that similar conclusions concerning certain Darwinian concepts were reached, although the leading members in this field belonged to the other intellectual trend - the rationalist, Westerner outlook.

Social Thought

Sociology, or the science of human society, was a new and developing field of knowledge in the 19th century. It was not, of course, the first time that man had looked at and studied the structure and development of his society, but it was the first time that the term sociology was used with its accompanying conception of the possibility of a science of society.

Auguste Comte, (1798-1857), the famous French philosopher, is called the father of sociology. Two of the main elements of his philosophy were the idea of the hierarchy of the sciences and his Law of the Three States. The three states were the Theological or fictitious state, the Metaphysical or abstract state and the Scientific or positive state. Each branch of knowledge was obliged in the course of its development to pass through these three theoretical states. For proof of his Law, Comte pointed to four fundamental sciences that had already reached the final or scientific stage: astronomy, physics, chemistry and physiology. In his hierarchy of sciences Comte placed biology and the science of man, sociology, in positions which had not yet reached the final state, but he believed that eventually they would achieve a scientific basis similar to that of physics or chemistry. Darwin's theory seemed to vindicate Comte's ideas brilliantly in the field of biology. It further encouraged sociologists to apply biological and other scientific mechanisms to the study of man, since sociology lay next door to biology in Comte's hierarchy of sciences and since Darwin had included man within his scheme of evolution.

Although Comte's first major work was published between 1832 and 1842, his ideas were not available to the

Russian public in Russian until 1867*, three years after the appearance of the Russian translation of the Origin of Species. Even then they came by an indirect route. They appeared in a volume called Auguste Comte and the Positivist Philosophy, a translation of two works by G.H.Lewes and J.S.Mill.(46) Other writers on social theory whose ideas became well known to the Russians in the 1860s included Buckle, Spencer, Mill and Lewes. However, the specific concept of sociology as a branch of knowledge and science does not appear to have been present in Russia before the end of that decade. It was only then that the Russians actually began using the word sociology in their writings and began referring to themselves as sohiologists.

By then members of the radical intelligentsia were altering their perspectives. The principles of nihilism and egoism and the belief in the possibility of a scientific re-ordering of society, ideas present in the early 1860s and closest to those of Spencer(and Buckle), had not fulfilled their promise. By 1867 of the three

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*Many years earlier a young intellectual Valery Maikov (1823-47) mentioned Comte in his writings, and perhaps if Maikov had lived longer the Russians would not have had to wait so long for a translation of Comte's works.

leading members of this trend of thought, Pisarev and Dobroliubov were dead, and Chernyshevsky was doing hard labour in Siberia. At the end of the decade the radical intelligentsia shifted its emphasis from nihilism, egoism and science or materialism to populism, altruism and an historical attitude.(47) The sociologists who came to the fore at this time, and the first Russians to call themselves by that name, were Lavrov, Mikhailovsky and Yuzhakov. They were all three members of the radical intelligentsia and their ideas reflect this change in emphasis. In fact it was a series of articles by Lavrov, written in 1870 and entitled <u>Historical Letters</u> that signalled the advent of the new intellectual trend. In these letters Lavrov stated quite clearly his opinion that the study of history was of more basic importance for the solution of contemporary social and political problems than the study of the natural sciences, important though these were. He also made the point that the most vital historical questions to be studied were those connected with the problems of sociology.(48)

Within this historical outlook Darwin's theory of evolution was important for the contribution that it had made to the study of the historical development of man and therefore of society. Menzbir, a scientist, wrote:-

> "Today we must understand sociology, which studies the laws of the formation of society in general, to be a branch of biology, and if sociologists do not include within the circle of their research the lower animals then they will not be able to find the root of many phenomena of man's social life."(49)

However, even though they generally accepted Darwin's theory of the evolution of man, Russian sociologists did not regard his actual mechanisms of evolution, such as the struggle for survival, as necessarily being totally applicable to human society. It has already been noted that there existed among Russian biologists a certain critical tendency towards the concept of the struggle for survival, and an emphasis in its stead on ideas of solidarity. Within sociology this tendency was also prominent and formed an important tenet of the distinct Russian school, called the subjective school of sociology. The chief characteristic of this school and the reason for its name was that it introduced subjective and teleological ideas into sociology. It saw the dynamic of the social process as a complex of psychical, biological, physical and economic forces but of these it emphasised the psycho-social activities and work of critically minded individuals as determining factors for the achievement of progress within organised society.(50)

The leading members of this school in the 1870s were Lavrov, Mikhailovsky and Yuzhakov.

Lavrov felt that the essential factor of human society was 'solidarity' or cooperation, not the battle for survival. He saw the social forms of man as having emerged out of the social forms of animals and he thought that the developing human social forms would gradually approach a social ideal.(51) Mikhailovsky acknowledged that man was engaged in a battle with the forces of nature but he did not think the concept was generally true within society itself.(52) Yuzhakov likewise replaced the struggle for survival between men with the struggle of men, united in solidarity, against nature. He believed that the increase in population would be balanced by the increased production of food, resulting from man's ability to manipulate nature.(53) Kareyev, a sociologist of the next generation, similarly thought that the principle of solidarity was basic to any society.(54)

The only internationally famous Russian sociologist to expound these ideas was Prince Kropotkin who became well known at the end of the century.* In the introduction to his book Mutual Aid, first published in 1902, Kropotkin wrote of his journeys in eastern Siberia and northern Manchuria, where he had failed to find the bitter struggle for existence among animals of the same species that he had been led to expect from Darwin's Origin of Species. He felt that natural checks to overpopulation, like storms, could not help the achievement of evolutionary progress since the species that survived them must be impoverished in vigour and health. He replaced struggle by the concept of mutual aid. Kropotkin saw no reason for admitting that the condition for progress was a pitiless war between man and man:-

> "On the contrary, a lecture 'On the Law of Mutual Aid' which was delivered at a Russian Congress of Naturalists, in January 1880, by the well-known zoologist, Professor Kessler, the then Dean of the St. Petersburg university, struck me as throwing a new light on the whole subject. Kessler's

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*Kropotkin's international fame may not have been the result of his work being more original than that of other Russian sociologists but may have primarily resulted from the fact that his period of work and fame coincided with the period when the solidarity school of sociology was popular in the West and Kropotkin was acknowledged as one of its leaders.

idea was that besides the Law of Mutual Struggle there is in Nature the Law of Mutual Aid, which for the success of the struggle for life, and especially for the progressive evolution of the species is far more important than the law of mutual contest. This suggestion - which was, in reality, nothing but a further development of the ideas expressed by Darwin himself in The Descent of Man - seemed to me so correct and of so great an importance, that since I became acquainted with it (in 1883) I began to collect materials for further developing the idea which Kessler had only cursorily sketched in his lecture, but had not lived to develop. He died in 1881."(55)

He defined Mutual Aid as follows:-

"It is . . . an instinct that has been slowly developed among animals and men in the course of an extremely long evolution, and which has taught men and animals alike the force they can borrow from the practice of mutual aid and support, and the joys they can find in social life . . . It is the unconscious recognition . . . of the close dependency of everyone's happiness upon the happiness of all."(56)

Further on in Mutual Aid Kropotkin made the point that those animals that had learnt the habit of mutual help, were better adapted than those that hadn't, and that in addition mutual aid helped the development of the intellect and reason. To support this latter point he cited the ants and termites as examples. Another Russian sociologist, M.Kovalevsky, found support for Kropotkin's argument in the fact, observed by the naturalist Severtsov, that falcons having bodies ideally suited for attack were dying out, whereas less perfected species that practised mutual help were flourishing and increasing.(57)

The emphasis on the inapplicability of the battle for survival to human society, in so far as it meant a battle between individuals, and the corresponding emphasis on mutual aid or solidarity as a primary factor of human society was common to other Russian writers besides the sociologists specifically mentioned above.(58) This trend of thought was derived from their concept of progress.

In western Europe and America there were two schools of thought on how society progressed. One, the 'sympathetic' school, advocated state intervention and welfare benefits. The other, the so-called 'scientific' school, advocated extreme laissez faire capitalism where the weakest went to the wall. This resembled Spencer's interpretation of evolution. In his <u>First Principles</u>

Spencer had said:-

> "Evolution is an integration of matter and concomitant dissipation of motion: during which the matter passes from a relatively indefinite, incoherent homogeneity to a relatively definite, coherent heterogeneity; and during which the contained motion undergoes a parallel transformation."(59)

If it was assumed that evolution was progressive, and this was a widely held assumption after the appearance of Darwin's theory, then it could be seen that Spencer's formulation amounted to the equation of progress with change in a direction of increasing complexity. The problem of human concepts of moral right and wrong did not really enter into his argument.(60) In reaction to this, the 'sympathetic' school developed the idea that progress in society had to contain some moral or ethical principles.* Darwin, himself, in his <u>Descent of Man</u> offered very confused advice on the moral problems of progress arising from his theory of evolution; there were both texts supporting rugged individualists and ruthless imperialists and texts supporting social

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*Huxley had said: "Social progress means a checking of the cosmic process at every step" in <u>Evolution and Ethics, 1893</u>; quoted in Hofstadter, Social Darwinism, p.77. Huxley's essays were translated into Russian but, though in agreement with many of the trends of the solidarity school, he does not seem to have a determining influence on its development.

solidarity and fraternity.[61]

It was difficult for a Russian intellectual, who saw the best minds of his generation being harassed by the government, being imprisoned and exiled, to believe in the concept of the survival of the fittest, within the terms of individual struggle as it was generally interpreted at that time. However, having replaced individual struggle by the concepts of group struggle with nature and of mutual aid within human society, many Russian sociologists still felt that there was nothing automatically progressive about human society even on these terms.

Mikhailovsky, Lavrov and Chernyshevsky all felt that progress had to be achieved by man consciously. Mikhailovsky said that development had to be guided by definite ideals and for him the progressive ideal was the development of the individual. Interestingly enough he felt that "ideals and the aspiration to realise them arise as fatally as the most passive adaptations of the lower animals."[62] Although he seems to have seen man's progressive ideals as the result of evolution, Mikhailovsky believed that these ideals had an influence on the actual progressive development of society. Lavrov similarly felt that progress could not be achieved by unconscious evolution:-

> "If we limit ourselves to theoretical understanding and refuse the actual battle for progress, we either do not understand the essence of this process or we consciously act against that which we ourselves acknowledge to be superior."(63)

Similar ideas were put forward by Chernyshevsky in an article he wrote during the 1880s which was never published. He too thought that men were distinguished from animals by their mental superiority and progress was achieved by man when he understood what was good for him and consciously strove to attain it.(64)

Lavrov developed these ideas in a theory of history which both rejected certain social ideas of Spencer and Darwinism and also introduced a different emphasis to the ideas of Comte. In his search for a deeper ideal guiding historical progress Lavrov was influenced by his early Hegelian philosophical training. In the essay 'Science and History' he wrote that there were three stages in the process of progress: the thesis, antithesis and synthesis of Hegel's famous law of dialectics. The first step was when man, who had previously placed himself at the centre of all existence, recognised

himself as just one of the countless results of the laws of the outer world. That development in thought was great progress without which science would be impossible, but it was only a first step which inevitably had to be followed by a second. This was the study of the unchanging laws of the outer world in its objectivity so as to attain such conditions for man as man himself subjectively recognised to be the best and most just. The third step was an apparent return to the first, but in reality solved the contradiction between the first and second. Man again became the centre of the world but not of a world existing independently of man but of a world consciously comprehended by man, subjected to his thought and directed towards his aims.(65)
This interpretation of social progress saw man's ideals and aspirations as of greater importance in history than any automatic social mechanisms. It was a definite rejection of the current interpretations of Spencer and Darwin and of Comte's attempt to make sociology a science, taking science to be a neutral observation of the facts.

Attacks on Darwin and Social Darwinism of a more direct and practical nature than those of Lavrov came from both Mikhailovsky and Chernyshevsky. Mikhailovsky strongly criticised Darwin for the use that had been made of his ideas in the social field. He felt that Darwin should and could have taken a firmer stand against the way his theory was interpreted by people such as Mme. Roye[66] and Renan.[67] He gave a biting criticism of Darwin's view on the instinct of the Queen Bee to kill her daughters:-

> "Having used the principle of use so often and so cleverly, Darwin hasn't noticed that the malice of the mother-bees is not at all useful either to the bees or to the bee society, but is only useful to the present form of that society, as it helps, of course, to retain that form."[68]

Mikhailovsky then made a parody of Darwin's attitude with respect to the Russian peasant:-

> "Although we find it difficult we can't help but be delighted with the wild drunkenness of the Russian peasant, as this is, without doubt, of great use to the society."[69]

In general Mikhailovsky felt that the concept of 'use' was interpreted in too many different ways by Darwin and the Darwinists: sometimes to mean useful to the individual, sometimes to the species, sometimes to the society and sometimes to mean useful to certain forms of society and that this concept would have to be defined more exactly before it was of great value to sociology.[70]

In addition to his criticism of the interpretation that Darwin had allowed to be made of his theory in the field of sociology, Mikhailovsky tried to show that Darwin's public influence had also been overrated.(71) In an essay he wrote on the occasion of Darwin's death he referred to Darwin as "the great bourgeois naturalist"(72) and went on to insist that Darwin's teaching had not played a great role in Russian life. Except for a small handful of specialists, whose work in some way had been influenced by Darwin's ideas, there only existed, he claimed, a mass of people who talked a lot but understood little. The newspapers were quite mistaken in comparing Darwinism to dynamite; there was absolutely no connection between the two. However there was room in Russia, as elsewhere, for the practical application and verification of certain aspects of Darwin's theory such as laws of variation, heredity, adaptation etc. Here Mikhailovsky wanted to reduce the public attention paid to Darwin's ideas to the proportion he thought they deserved.

Chernyshevsky too, felt that Darwin had been overrated. He himself had very early in his life read Lamarck and Lyell and had been a convinced transformist long before the publication of Darwin's book and all the ensuing fuss.(73) He remained a Lamarckian for the rest of his life and he interpreted the Lamarckian concept of the will of the animal as a mechanism in evolution with the natural urge of every living creature, including man, to improve his way of life. This idea was at the basis of Chernyshevsky's criticisms of Darwin. He felt that organisms can only improve both morally and physically under the influence of good conditions and he criticised Darwin very strongly for his use of Malthus's theory, which Chernyshevsky saw in a historical perspective as an attempt by the English government of that period to justify its policy of not introducing social reforms.(74) Although Chernyshevsky was here criticising Malthus on political grounds, there was sociological criticism of him as well in Russia. In fact the Russian tendency to reject the battle for survival contained within it an implicit criticism of Malthus.*

*Other examples of Russian criticism of Malthus include Pisarev who strongly criticised John Stuart Mill for his acknowledgement that society had the right to control marriages and forbid those which menace society with an increase of non-propertied citizens (Selected Philosophical, Social and Political essays, p.123); Billington describes (Icon and the Axe, p.318) how Prince Odoevsky (1804-69) was haunted by the writings of Malthus and wrote a sketch entitled 'The Last Suicide' which depicted humanity lighting a fire to relieve overpopulation, and then trying in vain to check the fire so as to save some vestige of life on earth.

Billington makes the point that the extreme pan-slavist movement sought justification for its ideas in social Darwinist theories of the superiority of races being proved by survival in war.(75) If this was true,(76) it might provide another reason for Chernyshevsky's opposition to Darwinism. Chernyshevsky interpreted Darwinism to mean a surrender to nationalism; in other words he made the same interpretation of Darwinism as did the pan-slavists. Therefore since he was opposed to their nationalist ideals and to the idea that good could be achieved through force, he rejected Darwinism in favour of the peaceful spread of culture and gradual evolution of society, ideas he equated with the evolutionary theories of Lyell and Lamarck.

Sociologists of a later generation, such as Kropotkin, were not so critical of the way Darwin had allowed his ideas to be used in the social field. Darwin had written that he saw the principle of the survival of the fittest "in a wide and metaphorical sense, including in it dependence of one being on another, and also implying what is even more important, not only the life of one individual but its success in preserving its future generations."(77) Kropotkin felt that the idea of mutual aid could be easily accommodated within this view.(78) Kropotkin's respect for Darwin may have resulted both from the fact that he had initially been a scientist himself, unlike the Russian sociologists of the 1870s, and also from the fact that at the time when he was writing the 'sympathetic' school of sociology had become strong in the west and Darwinism had lost its previous practically total equation with the 'scientific' school.

The characteristics of the Russian subjective school of sociology, the fact that this school appeared in Russia ten to fifteen years earlier than similar schools in western Europe and America and the fact that the Spencerian school of Darwinism, very prominent in the west, was virtually absent from Russia, resulted from the situation in Russia in the second half of the 19th century. Firstly all the Russian sociologists were active members of the radical intelligentsia.* They were not scholars

*Lavrov had to live in exile after escaping from Siberia in 1870; all his work appeared under a pseudonym as his name was forbidden to be mentioned in the legal Russian press, which only began to print his work under his real name after 1905, well after Lavrov's death. Mikhailovsky managed to avoid prison, but Yuzhakov spent three years, from 1879-82, in exile in Siberia. Prince Kropotkin escaped from prison in Russia in 1876 and had to remain in exile in Europe until 1917.

or members of the university in any way reliant on the autocracy for their living. As radicals they were seeking for ways to change Russian society and, as has been discussed in Chapter I, the two main elements in the radical movement of the 1870s were the rejection of the laisses faire attitudes of capitalism present in the west and a belief in the progressive values of the traditional peasant commune, at that time still existing in Russia. These two elements formed a natural part of the sociologists' outlook and obviously contributed to their rejection of Social Darwinism and the development of their theories of solidarity and mutual aid. Secondly, the emphasis of the subjective school of sociology on the importance of man's intellect and ideas in achieving progress can be seen to be a vindication by Lavrov, Mikhailovsky and Yuzhakov of their own political position. If ideas had a decisive importance in the making of history then they, as progressive thinkers, would be able to wield real influence to change Russian society.

Similarly the public attitude to the philosophical and religious aspects of Darwinian concepts was affected by the cultural traditions of Russia and the political and social situation it was in in the second half of the 19th century. The failure of the official orthodox church to capture the minds of the intellectuals and to oppose successfully the growing materialist ideas resulted from its own traditions and characteristics - its ties with the autocracy, its lack of autonomous intellectual tradition in secular affairs, its belief in revelation rather than reason and its general indifference to the possible danger of the new scientific knowledge undermining the precepts of religion. There may have been another more political factor. The bulk of the Russian population was made up of the peasantry, most of whom were illiterate and were not aware of the ideas being discussed by the very small minority of intellectuals in Moscow, St. Petersburg and the other large towns. The church did not fear for its authority among the peasantry, which was its traditional seat of power, and so was not tremendously concerned about the intelligentsia.

Reflections in Literature.

A brief survey of Russian literature of the second half of the 19th century generally confirms the picture already drawn up of the public attitude to Darwinian concepts.

In the 1860s the most important works reflect society's attitude to science, rather than Darwinism. In 1862 Turgenev published his novel Fathers and Sons. The hero Basarov was a student doctor and nihilist, in fact it was Turgenev's hero who gave the movement of the 1860s that name. Basarov was devoted single-mindedly to science which he saw as the only salvation of society. Timiriazev saw him as a true representative of the 1860s and compared his ruthlessness with that of Peter the Great's as necessary if Russia's archaic society was to change.(79) A few years later Chernyshevsky's novel What is to be Done appeared in the review Contemporary. It was a novel about the 'new people' who were to make up the 'new society' and here again both the main characters were men of science, doctors. They were practical men whose aim in life was to help people to improve their lot, by basing their lives on rational principles.

In contrast to this trend there was Dostoevsky's rejection of science in Letters from the Underworld published in 1864. Steinberg has suggested that Dostoevsky's stress on ideas and his concept of a geneological tree of ideas may have developed in deliberate opposition to Darwin's <u>Origin of Species</u>. The basis of this suggestion is that in <u>Letters from the Underworld</u> when the question of the possibility of attaining human freedom under the reign of the natural sciences was posed, the hero advanced his method of investigation of ideas as an antidote against the scientific approach.(80) In this work Dostoevsky made a specific though extremely ironic reference to Darwin's theory:-

> "When for instance, people of this kind seek to prove to you that you are descended from an ape, it is no use for you to frown; you must just accept what they say . . . 'pardon us', so these people bawl, 'but you simply <u>cannot</u> refute what we tell you . . . no matter whether you approve of her [nature's] laws or not. You must take her as she is and, with her, her results. . .'"(81)

The one Russian writer who may have been influenced directly by Darwin's ideas is Chekhov. He was a doctor by training and certainly had a great respect for Darwin as a scientist and thinker.(82) In his four great plays there is always a character who looks to the future and sees the development of a better world within the next two or three hundred years. In The Three Sisters the battery commander, Vershinin, describes this process, which could be interpreted to be the concept of natural selection as described by Timiriazev in his polemic with Strakhov:-(83)

> Vershinin: ". . . It seems to me that there's no place on earth, however dull and depressing it may be, where intelligence and education can be useless. Let us suppose that among the hundred thousand people in this town, all of them, no doubt, very backward and uncultured, there are just three people like yourselves. Obviously you can't hope to triumph over all the mass of ignorance around you; as your life goes by, you'll have to keep giving in little by little until you get lost in the crowd, in the hundred thousand. Life will swallow you up, but you'll not quite disappear, you'll make some impression on it. After you've gone, perhaps six more people like you will turn up, then twelve, and so on, until in the end most people will have become like you. So this old earth of our's will have become marvellously beautiful . . ."(84)

In general, however, most Russian writers do not seem to have been specifically concerned with Darwinian concepts in their writing, a fact which confirms the situation outlined in this chapter. If the main concern of Russian intellectuals was Russia's identity and historical destiny, in which debate Darwinism played only a small secondary role, then it was to be expected that the literature would reflect the dominant ideas under discussion in society and would not consider Darwinian concepts to be of vital importance. Issues of more relevance were of course reflected; issues such as materialism and idealism, the growing capitalism and in contrast to it the values of the peasant commune.

CONCLUSION

Poincare posited that the general propositions enunciated by scientists were hypotheses designed to crystallise and organise further thinking and were subject to verification, modification or refutation.(1) At the same time an hypothesis cannot be totally non-objective. Whewell wrote "No general statement . . . not even the simplest iterative generalisation, can arise merely from the conjunction of raw data. The mind always makes some imaginative contribution of its own, always 'superinduces' some idea upon the bare facts. A hypothesis is an explanatory conjecture giving one of many possible explanations that might meet the case . . . . Yet it is indispensably necessary for the discoverer to demand of his hypothesis 'an agreement with facts such as will withstand the most patient and rigid enquiry', and, if they are found wanting to turn them resolutely down . . ."(2)

Hypotheses vary in the extent that they rely on the imagination. There are some, such as the theory of circulation of the blood, which can be verified fairly easily and which soon assume the status of a fact.

There are others, however, such as the theory of evolution or cosmological hypotheses, which are much more difficult to prove experimentally and whose acceptance is dependent to a certain degree on an act of faith. Since Darwin's theory of evolution involved man's imagination as well as his reason it had to be evaluated from both these points of view - the ethno-cultural and the empirical scientific.

It was impossible to successfully prove the validity of Darwin's theory of evolution of the species. Its principle tenet, that of the development and variation of species over enormous periods of time, ruled out the possibility of valid experimental proof; nor were many of the constituent processes of the theory, such as heredity and variation, well enough understood scientifically. Up to the time of the rediscovery of Mendel's laws and the period of intensive work on heredity at the turn of the century, most scientific criticisms of and adaptations to the theory of natural selection, theories such as neo-Lamarckism and neo-Darwinism, were valid in the sense that Darwin himself had been unable to provide a totally satisfactory theory; however, these alternatives proposed were often no more scientifically satisfactory than the theory they were trying to improve upon.

The content of the criticism levelled by scientists at Darwin's theory of evolution by natural selection did not differ from country to country. The scientific methodology and consequent edifice of knowledge that had flourished in Europe since the renaissance was common not only to Europe, including Russia, but also to the European in America and other areas of the world where he had carried his culture with him. However, there were differences in different countries in the reception that scientists gave to Darwin's ideas and in the impact that those ideas had on scientific research. These differences seem to have been partly dependent on the national scientific traditions or cultural mores of the specific country.

In Britain - the home of the two founders of the theory of evolution by natural selection - there emerged a strong group of scientists who gave their support to the theory. At the same time, Robert Owen, a member of the older generation of scientists and a supporter of the catastrophist point of view, formed a focal point for opponents of the theory. Agassiz played a similar role in the United States of America. In France the ideas of Darwin took a long time to be recognised because, for the French, Lamarck had said it all before. In addition any theory of evolution had the influence and reputation of Cuvier to contend with, especially after his defeat of Geoffroy Saint Hilaire on the question of transformism. In Germany there were groups of scientists strongly supporting Darwin and others who strongly opposed his theories.

It was certainly significant that in Russia there was no group of influential scientists opposed to Darwin's theory, acting as a focal point for opposition in the society. This situation was both natural and a result of chance. Russia was in some ways in a similar position with regard to the development of its sciences as the United States of America. In 1859 in both countries the natural sciences were young, only just beginning to stand on their own feet and had few well established traditional schools of thought. In Russia, the native tradition in biology tended towards transformism perhaps a result of the large Russian Empire with its very varied fauna and flora. This tendency was not upset by any of the foreign scientists invited to Russia, none of whom had Agassiz's absolute belief in catastrophism or were of his influence and stature. In the United States of America there also existed a certain native tradition receptive to ideas of evolution, represented by Asa Gray, but at the time of the publication of the Origin of Species Agassiz happened to occupy an extremely influential position which consequently influenced the attitudes of other American scientists towards the theory.

The impact that Darwin's theory had on the content of scientific research was also partly determined by national peculiarities of scientific development. It is interesting that important strides were made in evolutionary palaeontology in Russia and the United States, both countries where geology was a very recently established discipline. In Russia too, many of the young student botanists of the 1850s and 1860s specialised in plant physiology, a totally new branch of science closely connected with the problems of the theory of evolution. Darwin himself turned more and more of his attention to this subject after 1859 but it was sometime before it was widely established in England. There also developed a strong school of evolutionary embryology in Russia after 1859. The coincidence of the publication of the Origin of Species with the emergence of the natural sciences meant that the concept of evolution by natural selection was not received by scientists who were already working within a traditional framework of research but was received and accepted by young student scientists who were to build up through the rest of the century the traditions of scientific research generally absent in Russia in 1859.

Thus we find that although the content of scientific criticisms levelled at the theory of evolution through natural selection were similar, the pattern was variable according to the native scientific traditions.

Proof that Darwin's theory was "an agreement with the facts such as will withstand the most patient and rigid enquiry" depended upon time; today the theory of evolution and the question of the origin of the species are still not finally established, although some of the stumbling blocks that faced Darwin, such as his lack of knowledge of the laws of heredity and variations, are now better understood. Consequently in the 19th century the major controversies surrounding the theory of evolution through natural selection were of a more emotive or imaginative character.

The two moral and religious difficulties presented by the theory of evolution were firstly the question of the authenticity of Genesis and secondly the question of God's place in nature and His relationship to men. The second was of more fundamental importance than the first. The verses of Genesis had been accepted literally by practically the whole of Christendom up to the mid-17th century. However the discovery of America had shocked the medieval mind. Questions arose as to the origin and dispersal of animals and man on this new continent since the Mosaic flood. More difficulties came with Linnaeus' classification of a large number of species - far more than could have ever possibly fitted into the ark. The development of geology and especially of Lyell's uniformitarian theory that demanded an enormous length of time since the origin of the earth had hindered still further the possibility of a literal interpretation of the mosaic flood and story of genesis. Thus Darwin's theory did not present anything basically new in criticism on this side.

However, the question of God's place in nature, of man's place in nature and of his relationship to animals and to God was posed very sharply by Darwin's ideas. It was difficult for man to believe that he had descended from the apes and was therefore essentially no different from other animals. Many people, scientists included, felt the need to find some answer to this problem. St. George Mivart and Wallace both suggested that man had a double nature: his body had evolved in a natural way, but his soul or rational part had a different origin. These questions, of course, were not essentially new. The theory of evolution did not raise them for the first or the last time, though it did perhaps pose them in its own distinctive way. They remain to the present day, no more soluble now than then, forming part of the national cultural myth. However, in the religious debates that raged about Darwinism these more fundamental questions were raised as well as the specific difficulties of the truth of genesis.

The form and pattern of the religious debates that took place in various countries resulted from the attitudes of the representatives of official religion and how far they felt that their status quo was being threatened by the new theory.

The early 19th century saw a rise in the influence of the church and of religious orthodoxy in the western world. There were a number of reasons to account for this. There was the pietistic reaction against the French revolution; the romantic idea of God pervading all of nature took the place of 18th century rationalism. In England and America the protestant revival was especially strong and it took a generally fundamentalist form with the literal truths of the bible being stressed. In England religious orthodoxy had been shocked by the Oxford movement in the 1830s and by the secessions of Manning, Newman and others to the Roman Catholic church. Consequently official religion was not only active and more than usually influential around the 1850s but was also very sensitive to anything that seemed to prejudice the truths that it stood for.

Thus we find that the representatives of the church in these countries came out very strongly and emotionally against Darwinism. There was Bishop Wilberforce in England famous for the incident at the British Association meeting in Oxford where he turned to Huxley and asked him whether it was through his grandfather of his grandmother that he traced his descen~~dence~~t from the ape. While in the United States the leader of the Episcopal church spoke in these terms: "If this hypothesis be true, then is the bible an unbearable fiction . . . then have Christians for nearly 2000 years been duped by a monstrous lie? . . . Darwin requires us to disbelieve the authoritative word of the Creator."(3)

In Russia the picture was very different, a result of the fact that the representatives of the orthodox church neither had the tradition nor felt the need to defend their religion; in any case the church did not feel threatened by an intellectual theory which ninety per cent of the population, the peasantry, had probably not heard of. Consequently there were no priests or bishops who stood up to defend the literal truths of Genesis or to denounce Darwinism as an anti-religious influence.

This did not mean, however, that the more important religious questions raised by the theory of evolution were not present in Russia. The question of man's place in nature and of God's role were discussed widely but here the discussion did not necessarily take place among theologians or even practising Christians but often among idealist thinkers who had rejected the Orthodox Christianity of official religion. It has to be also said that the idealist thinkers did not pose their ideas of God and man and religion and spiritual life in opposition to Darwinism. Darwin's theory had coincided with a period of tremendous scientific development and belief in science in Russia in the 1860s so the idealist trend was more an answer to and discussion of the general problems raised by science and western European culture than the specific questions raised by Darwin. And these two trends in their own turn were part of the Russian quest for an identity.

The other important discussion involving Darwin's ideas was around the question of social Darwinism. Darwin's work had shown that the whole history of life on earth was open to scientific investigation. The prevailing scientific methodology was now applicable to yet another branch of biology, and since man was included Darwin's work underlined the idea that all aspects of man could in the future be subject to scientific investigation. Both Darwin and Wallace had been influenced by Malthus's Essay on Population and this gave the biological and sociological sciences even closer links. Darwin had taken one of the basic tenets of the concept of natural selection from sociology. The sociologists, in their turn, after the publication of the Origin of Species, took Darwin's theory and applied it to society. However, it was a theory open to many interpretations and so was generally made to fit the prevalent attitude of society at any particular time.

In all the countries of western Europe and in North America there were influential thinkers who interpreted Darwinian concepts of natural selection and the survival of the fittest to mean justification for methods of laissez faire capitalism where the strongest wins and the weakest go to the wall. In Germany at the time of the Franco-Prussian war it was also interpreted to mean the justification of the survival of the strongest nation or race, and in Russia too there is a possibility that Darwinism was used in this way during the Balkan wars and period of extreme pan-slavism in the 1870s and 1880s.

In the United States and most of Europe, Social Darwinist ideas predominated throughout the 1870s and 1880s. Existing parallel with them and perhaps a reaction against them was the trend of social thought that believed in state intervention and in the alleviation of some of the ills brought on by industrialisation and the development of capitalism. In England and the United States this latter trend did not gain much strength until the end of the century when capitalism had passed through some bad slumps and when the workers were beginning to join together and organise themselves into trade unions.

Russia again was an exception to this general pattern of social ideas and the reason is found in her economic and social conditions. Although Russia was a slowly developing capitalist country in the second half of the 19th century, its industrial middle class was small and weak. The merchant class of feudal Russia which could have formed its backbone had tended to opt out of the modern developments encouraged by Peter I's westernizing policies; much of the capital for the development of industry in the 19th century came from abroad. In addition, what middle class did exist, was still part of a basically feudal autocratic social structure and had little political leeway or tradition of independent thought. The members of the intelligentsia were the main source of ideas in Russia and they, in the 19th century, despised capitalism as much as they despised feudalism and serfdom. Consequently, right from the beginning no sympathy was found for the application of Darwin's concept of the survival of the fittest to society as it was then interpreted in western Europe. The members of the intelligentsia developed their own distinctive school of sociology "the subjective school" based on their belief in the beneficial social role of the community life of the peasant, at that time still apparently existing in the Russian countryside.

The peculiarities of the reception of Darwinian concepts in Russia arose out of the cultural and scientific traditions of that country. When a scientific theory such as Darwinism, which had a direct impact on the way in which man regards himself, is disseminated and assimilated within a single country, there begins a two-way process. The theory influences the ideas of the people; at the same time the traditions and culture of the country have their own impact causing specific emphasis and interpretations to be put on the theory. Although this latter process is most noticeable in the ideas of the society as a whole, it can also be traced among the scientists, who, of course, also exist within the cultural ethos of the country.

NOTES.

Complete authors' names, titles, and publication data are given in the Bibliography.

CHAPTER I

1. The Russian word for science is 'nauka' and it is closer in meaning to the German 'wissenschaft' (which includes history and philosophy as well as the natural and social sciences) than the narrower English word science.

2. For further information about the Russian class system see pp. 17-18.

3. Development of Capitalism 1865-90:

   no. of factories increased from c.2,700 to 6,000
   no. of workers in large factories, mines and railways increased from c.700,000 to 1,432,000
   no. of miles of railway increased from 2,500 to 18,000
   in 1890 48.3% of industrial workers were concentrated in industrial enterprises employing more than 500 men. [History of C.P.S.U.]

4. 'The Cherry Orchard' by Chekhov is an illustration of this.

5. The Gentry was a class which covered both the hereditary nobility and members of the bureaucracy of certain high grades. Peter I had instituted a series of 14 grades or ranks in the civil service which corresponded to ranks in the army. The higher ranks of both the civil and military services belonged to the gentry class.

6. Billington. The Icon and the Axe, pp. 191-6.

7. From the Russian words 'rasnye' meaning different and 'chin' meaning rank.

8. For example: Belinsky, literary critic, was the son of an army surgeon; Timiriasev, a botanist, was the son of a custom's official; Chernyshevsky, a leading member of the radical intelligentsia, was the son of a priest; Roullier, a zoologist, was the son of a French immigrant.

9. Slavianski arkhiv, Moscow, 1958, 211. Quoted in Billington, p. 373.

10. <u>Karamsin, Nikolai Mikhailovich</u> (1766-1826): widely travelled aristocrat. Writer and journalist. Wrote 12 volume History of Russian State (1816-26) and advocated autocratic monarchy as the best rule for Russia.

11. Although no journals seem to have been specifically closed down after 1848, they did not really flourish until 1855 when the seven dark years had come to a close (Brockhaus-Efron, vol. 12, 1894, p. 62)

12. An example is the members of the Petrashevsky circle who were arrested in 1849. Some of them including Feodor Dostoevsky were sentenced to death, the sentence being commuted to hard labour when they were already in front of the firing squad.

13. K.F.Roullier, professor of zoology at Moscow, was forbidden to read public lectures and had to read his university lectures in the presence of the dean or rector from 1851 to his death in 1858. (Raikov, Russkie biologi-evoliutsionisty, vol. 3, pp. 191-2, 199, 205.)

14. "Upon a ministerial report which concluded with the word 'progress', Nicholas wrote the comment "Progress? What Progress? This word must be deleted from official terminology."" (Masaryk. Spirit of Russia. Vol. 1, p. 113)

15. Timiriazev, "Probuzhdenie estestvoznaniia", p. 1.

16. Belinsky, Polnoe Sobranie Sochinenie, vol. XII, pp. 22-3.

17. Wallace, Russia, 1877, pp. 261-5; 1912, pp. 606-9.

18. Moleschott, Jacobus (1822-93): Dutch physiologist. Member of school of extreme materialist philosophy in Germany.

19. Buchner, Ludwig (1824-99): German materialist philosopher.

20. Saltykov-Shchedrin, Mikhail Evgrafovich (1826-89): Russian writer and satirist, well known for his depiction of the degeneration of the Russian gentry after the emancipation.

21. Pisarev, "Tsveti nevinnovo yumora". Referred to in "Literatura 70-x godov" by O.N.Ovsianiko-Kulikobsky. Istoriia Rossii v XIX veke, vol. VII, p. 45.

22. Masaryk, The Spirit of Russia, vol. II, p. 5.

23. Berdyaev. The Origin of Russian Communism. Quoted in Kohn, The Mind of Modern Russia, pp. 12-13.

24. Masaryk, The Spirit of Russia, vol. II, p. 469.

25. Berdyaev. The Origin of Russian Communism. Quoted in Kohn, The mind of Modern Russia, pp. 12-13.

26. 'Narod' is the Russian word for people.

27. The peasant belief in the Tsar was so great that some narodniki tried to convince the peasants of their ideas by saying that they had been sent by the Tsar.

28. Billington, The Icon and Axe, pp. 406-7.

29. Such as C.N.Leontov (1831-91) mystic philosopher; N.Y.Danilevsky (1822-85) biologist and slavophile; N.N.Strakhov (1828-96) slavophile philosopher. More details of their ideas are given in Chapter 87.

30. Masaryk, The Spirit of Russia, vol. II, p. 487.

31. Trotsky, The Russian Revolution, pp. 4-5.

32. Wallace, Russia, 1877, p. 425.

33. Brockhaus-Efron, 1902, vol. 34, p. 791. See also p. 51.

34. Wallace, Russia, 1877, pp. 431-2.

35. Belinsky, Estetika i Literaturnaia Kritika, vol. II, p. 636.

36. This letter written by V.Zaitsev, a contributor to the progressive review Russian Word illustrates this point:

> "I swear to you by everything which I hold sacred, that we were not egotists as you call us . . . we were profoundly convinced that we were fighting for the happiness of human nature, and everyone of us would have gone to the scaffold and would have laid down his life for Moleschott or Darwin."

(Stepniak, Underground Russia, p.6.)

37. See above.

38. Belinsky, Estetika i Literaturnaia Kritika, vol. II, p. 636.

39. Tolstovskii Musei, vol. II, p. 404.

CHAPTER II

1. Vucinich, Science in Russian Culture, p. 76.

2. Figurovskii, ed., Istoriia estestvoznaniia v Rossii, vol. I, part 2, p. 25.

3. The Moscow Medical-Surgical Academy was founded in 1799, and the St. Petersburg one in 1800. Both were continuations of previous medical colleges. The Mining Institute was founded in 1774 and in 1804 received a new charter and status. The Artillery Academy was founded after 1791. The St. Petersburg Practical Technology Institute was founded in 1828.

4. Brockhaus-Efron, vol. 34, 1902, pp. 789-90.

5. Vucinich, Science in Russian Culture, pp. 200-3.

6. Rozhdestvenskii, ed., Istoricheskii obzor, pp. 105-6.

7. Ibid. pp. 105-6.

8. Brockhaus-Efron, vol. 34, 1902, pp. 791-2.

9. Ibid. p. 791.

10. Ibid. p. 791. Rozhdestvenskii, ed., Istoricheskii obzor, pp. 241-7.

11. Vucinich, Science in Russian Culture, p. 295.

12. Rozhdestvenskii, ed., Istoricheskii obzor, pp. 258-65.

13. Brockhaus-Efron, vol. 34, 1902, p. 794.

14. Granat ed., Istoriia Rossii v XIX veke, vol. IV, p. 194.

15. Rozhdestvenskii ed., Istoricheskii obzor, pp. 357-8.

16. Granat ed., Istoriia Rossii v XIX veke, vol. IV, pp. 189-90.

17. The 1864 university charter was close in spirit to the 1803 charter.

18. Rozhdestvenskii ed., Istoricheskii obzor, p. 424.

19. Wallace, Russia, 1912, pp. 622-3.

20. Rozhdestvenskii ed., Istoricheskii obzor, pp. 615-0; Granat ed., Istoriia Rossii v XIX veke, vol. IX, pp. 118-9.

21. Vucinich, Science in Russian culture, p. 75.

22. These figures are derived from the lists of members in Ist. Akad. Nauk SSSR, ed. by Ostrovitianov.

23. "Lichny sostav Imp. Akad. nauk v kontse 1852 goda", Ucheniia zapiski Imp. Akad. nauk po Pervomu i Tret'emu otdeleniiam, I (1853) pp. 580-9, quoted in Vucinich, Science in Russian Culture, p. 357.

24. Figures derived from list of Academicians given in Ist. Akad. nauk SSSR, ed. by Ostrovitianov.

25. Ostrovitianov ed., Ist. Akad. nauk SSSR, p. 274.

26. Ibid. pp. 274-5; 449.

27. See p. 18.

28. Brockhaus-Efron, vol. 34, 1902, p. 755.

29. Vucinich, Science in Russian Culture, p. 219.

30. Ikonnikov, "Russkie universitety," p. 549.

31. Vucinich, Science in Russian Culture, p. 219.

32. Ikonnikov, "Russkie universitety," p. 122.

33. Rozhdestvenskii, ed., Istoricheskii obzor, p. 424.

34. Vucinich, Science in Russian Culture, p. 221. This figure of 450 did not include the number of students at Vilna, Poland, or Helsinki, Finland. It was made up as follows:

Moscow	135	Kazan	40
Dorpat	193	Kharkov	82

35. In a letter printed in Russkoe Slovo (1860, no. 3, pp. 74-7) on entrance exams to the universities the writer stated that of 900 students who tried to enter St. Petersburg and Moscow universities only 200 were admitted.

36. These figures are compiled from various sources. "Materialy dlia istorii i statistiki nashikh gimnazii", Zhurnal Ministeratva narodnogo prosveshcheniia, vol. CXXI (1864), section 2, pp. 147, 150-1, quoted in Vucinich, p. 220; Ikonnikov, "Russkie universitety," pp. 108, 113.

37. Khodnev, Istoriia imperatorskogo vol'nogo ekonomicheskogo obshchestva, p. 1.

38. Shevyrev, Istoriia Imperatorskogo Moskovskogo universiteta, p. 402.

39. Figurovskii ed., Istoriia estestvoznaniia v. Rossii, vol. I, part 2, pp. 28-9.

40. Ibid. pp. 29-30.

41. Veselovsky, Istoriia Imperatorskogo Russkogo Arkheologicheskogo obshchestva, pp. 60-2.

42. Granat ed., Istoriia Rossii v XIX veke, vol. IX, pp. 121-2.

43. Anuchin, O liudiakh russkoi nauki i kul'tury, pp. 252-5.

44. In 1865 there were 28 scientific societies and in 1871 the number had reached 40, according to Ostrovitianov, Ist. Akad. Nauk. SSSR, p. 276; see also Sechenov, "Nauchnaia deiatel'nost'," p. 336.

45. These popular Russian journals usually depended on the initiative and enthusiasm of a single person and so were often short-lived. e.g. The Technological Review was published by the Academy between 1804-26 on the initiative ~~of~~ and under editorship of Severgin; The Herald of the Natural Sciences was published by the Moscow Society of Naturalists between 1854 and 1860. It was started by Roullier. He died in 1858 and the review did not last long after that date.

46. The Academy occasionally provided extracts of important scientific articles in Russian.

47. See appendix for their names.

48. Sechenov, "Nauchnaia deiatel'nost'," pp. 339-41.

49. Vucinich, Science in Russian Culture, p. 198.

50. Ikonnikov, "Russkie universitety," p. 96.

51. Nofontov, A., 1848 god v Rossii, Moscow-Leningrad, 1931, pp. 64-8, 71, 78; quoted in Billington, Icon and Axe, pp. 378-9.

52. Vucinich, Science in Russian Culture, p. 198.

53. Ostrovitianov, ed., Ist. Akad. Nauk. SSSR., pp. 249-52.

54. Shevyrev, Ist. Imp. Mosk. univ., p. 456.

55. This point is illustrated by the terms of the 1836 charter, see pp. 52-3.

56. Baer, Autobiografiia, p. 19.

57. Peter Simon Pallas led two important expeditions, from 1768-74 and from 1793-4; Middendorff explored the Kolskii peninsula in 1840 with Von Baer, and 1842-5 he led an expedition to Siberia.

58. These words are not in any dictionary but their Greek origins suggest the meaning of species or differentiation and hills, perhaps geology, respectively.

59. Ikonnikov, "Russkie universitety," p. 95.

60. Rozhdestvenskii, ed., Istoricheskii obzor, p. 247.

61. Shevyrev, Ist. Imp. Mosk. univ., pp. 573-4.

62. See appendix.

63. Shchapov, A.O.Sochineniia, vol. 3, St. Petersburg, 1906-8, p. 306; quoted in Vucinich, Science in Russian Culture, p. 199.

64. Figurovskii, ed., Ist. estestvoznaniia v Rossii, vol. I, part 2, pp. 26-7.

Although there was a generally increased emphasis on scientific subjects there may have been abias towards the mathematical sciences as they were then the best established in Russia. The 1804 charter for instance, did not provide for the teaching of zoology, except indirectly on the Medical faculties.

65. Shevyrev, Ist. Imp. Mosk. Univ., p. 365.

66. Bogdanov, "Karl Frantsovich Roullier is ego predshestvenniki," p. 101.

67. Ibid. pp. 102-3.

68. Ibid. pp. 92-3

69. In 1859 a reviewer of a Russian translation of Virchow's Cellular Pathology commented that there was a lack of good medical literature in Russia, especially on mácroscopic material. See Russkii Vestnik, 1859, vol. 24, pp. 73-5.

70. Timiriazev, "Probuzhdenie estestvosaniia," p. 21.

71. Timiriazev, Razvitie estestvoznaiia, pp. 31-2.

72. Sechenov, "Nauchnaia deiatel'nost'," p. 334.

73. Ibid. pp. 334-6.

74. The first All-Russian Congress of Scientists and Doctors was held in 1867 in Kiev, mainly on the initiative of Professor Karl Kessler.

75. Sechenov, "Nauchnaia deiatel'nost'," pp. 339-41.

76. According to Sechenov the amount received by the Societies was 2,500 roubles, presumably per annum though Sechenov does not specify. See "Nauchnaia deiatel'nost'", p. 127.

77. Perepiska A.O. Kovalevskogo, p. 127.

78. Granat ed., Istoriia Rossii v XIX veke, vol. IX, p. 119.

79. The dates of the Congresseswere as follows:-

1867	St. Petersburg	1876	Warsaw
1869	Moscow	1879	St. Petersburg
1871	Kiev	1883	Odessa
1873	Kazan	1898	Kiev

80. Ostrovitianov, ed., Ist. Akad. nauk SSSR, p. 19.

81. See Chapter I.

82. Brockhaus-Efron, vol. 26, 1899, p.80; Vucinich, Science in Russian Culture, p. 180.

83. Herzen, Sobranie sochinenii, vol III, pp. 91-122.

84. Timiriazev, "Probuzhdenie estestvoznaniia", p. 23.

85. Anuchin, O liudiakh russkoi nauki i kul'tury, pp. 252-5.

86. Ibid. pp. 252-3.

CHAPTER III

1. Merz, History of European Thought, vol. II, pp. 298-9.
2. Beitrage zur Entwickelungsgeschichte des Huhnchens im Eye. Wurzburg. 1817.
3. Thomson, J.A., in article 'Embryology', Encyclopaedia Britanica, 9th edn., p. 165; quoted in Merz, vol. II, p. 299.
4. Darwin, Origin, 6th edn., p. 394.
5. See p. 77.
6. Severtsov, Periodicheskie yavlenie, p. 17.
7. Bogdanov, Roullier i ego predshestvenniki, p. 58.
8. Severtsov, "Zoologicheskaya Etnografiia", p. 21.
9. Roullier, "Somneniia v Zoologii kak nauki", Otechestvenniye Zapiski, vol. XI, 1841, pp. 11-12; quoted in Alekseev ed., Khrestomatiia, p. 274.
10. See Russkii Vestnik, 1861, vol. 36, pp. 26-7.
11. Brandt, "Pozvonochnie zhivotnye severnoevropeiskoi Rossii", pp. 4-5.
12. In his 'Comparative Osteology' published in 1821.
13. This journal was published from 1820 to 1830.
14. Galakhov, A.D., "Philosophiia anatomii", Otechestvennye Zapiski, 1843; see Figurovskii, Istorii estestvoznanii v Rossii, p. 324. Galakhov was a historian of Russian literature.
15. At Moscow university Professor M.G.Pavlov was influenced by Schelling; Maksomovich was influenced by Oken. Shchurovsky was influenced for a while by Pavlov and Maksimovich. At St. Petersburg professors D.M.Vellansky, Y.K.Kaidanov and P.F.Gorianimov, who all worked in the Medical Surgical Academy, were all followers of naturphilosophie.

16. Vucinich, Science in Russian Culture, p. 156.

17. See Darwin, Variation under Domestication, 2nd ed., vol. I, pp. 202, 398.

18. Ibid.

19. Mechnikov, O Darvinizme, p. 19.

20. See Brockhaus-Efron, vol. 22, pp. 641-2; entry on Pallas illustrates emphasis Russians put on Pallas's ideas.

21. Merz, History of European Thought, vol. II, p. 301-2.

22. Baer, Istoriia razvitiia zhivotnykh, p. 320.

23. Quoted in Merz, p. 350.

24. Mémoires de l'Académie des Sciences de St. Petersbourg, vol. VIII, pp. 342-4; quoted in Baer, Istoriia razvitiia zhivotnykh, p. 455.

25. Darwin, Origin, 6th edn., p. 20. Huxley had known of Von Baer's work for some time and may have introduced Darwin to it.

26. Baer, Reden und Wissenschaftliche Abhandlungen. Bd. II, p. 264; quoted in Merz, vol. II, p. 317.

27. Roullier, Izbrannye biologicheskie proizvedeniia, pp. 139-40; for similar ideas see also "Obshchaia zoologiia", p. 11.

28. Roullier, Izbrannye biologicheskaia proizvedeniia, pp. 30-31.

29. Roullier, "O pervom poiavlenii rastenii i zhivotnykh na zemle", Moskovskie Vedomosti, 1852, no. 4, Jan. 8; quoted in Alekseev ed., Khrestomatiia, p. 269.

30. See p. 109.

31. Severtsov, "Zoologicheskaia etnografiia".

32. Ibid. p. 35.

33. Revue et Magazin de Zoologie pure et applique, vol. IX, 1857, pp. 435-7, translated into Russian by V.I.Kremiav; quoted in Alekseev ed., Khrestomatiia, p. 285.

34. Baer, Istoriia razvitiia zhivotnykh, pp. 454-5.

35. Baer, Avtobiografiia, pp. 458-9.

36. Roullier, "O zhivotmom Moskovskoi gubernii", p. 2.

37. Ibid. p. 2.

38. Roullier, Izbrannye biologicheskaia proizvedeniia, p. 78.

39. Roullier, "Obshchaia zoologiia", p. 130.

40. Beketov, "Garmoniia v prirode".

41. Ibid. p. 543.

42. For similar ideas in Russia see Dobroliubov, Selected Philosophical Essays, pp. 90-1.

43. Severtsov, Periodicheskie yavlenie, p. 20.

44. Ibid. p. 23.

45. Anuchin, O liudiakh russkoi nauki i kultury, p. 238.

46. Figurovskii ed., Istoriia estestvoznaniia v Rossii, vol. I part 2, pp. 220-1.

47. For example P.I.Meder, who lectured in the Mining College in St. Petersburg, and his pupil D.I.Sokolov who was at first a follower of Werner.

48. Ostrovitianov, ed., Ist. Akad. Nauk SSSR, p. 109.

49. Bogdanov, Roullier i ego predshestvenniki, p. 44.

50. Buch, Leopold von (1774-1853) German geologist.

51. Figurovskii, ed., Istoriia estestvoznaniia v Rossii, vol. I, part 2, p. 241.

52. Vucinich, Science in Russian Culture, pp. 344-5.

53. Ibid. p. 345.

54. Ibid. p. 345.

55. Ibid. pp. 209-10; Billington, The Icon and the Axe, p. 310.

56. Herzen, Sobranie sochinenii, vol. III, pp. 91-122.

57. Ibid. p. 92.

58. Roullier, Izbrannye biologicheskie proizvedeniia, p. 139.

59. See Chapter I, note 14.

60. Borzenkov, "Istoricheskii ocherk napravlenii sushchestvovavshikh v zoologicheskikh naukakh v XIX stoletii", p. 42; quoted in Raikov, Russkie biologi-evolutsionisty do Darvina, vol. III, p. 320.

CHAPTER IV

1. See p. 138.

2. See Chapter II, note 60; Mechnikov, O, Life of Elie Mechnikov 1845-1916, pp. 41-2; Timiriazev, "Kniga Darvina. Ego kritiki i kommentatory", Otech. Zap., no. 10, p. 656.

3. According to Darwin the first three Russian editions were made from the 2nd English edition of the Origin of Species. See Origin of Species, 6th edition, p. 11.

4. Timiriazev, "Kniga Darvina," Ot. Zap., no. 10, p. 656.

5. Pisarev, Selected Philosophical Social and Political Essays, p. 490.

6. I have been unable to see a copy of this first Russian edition of the Origin of Species and so cannot comment on the accuracy of these two descriptions.

7. Ratner and Shafronovskii, "Pervye perevody rabot Ch. Darvina," p. 115; Antonovich, Charl'z Darvin i ego teoriia, p. 252.

8. Darwin, Life and Letters, p. 73. Darwin's figure of four for the number of Russian editions of the Origin was inaccurate at this time. The 2nd edition came out in 1865 and the 3rd in 1873. The confusion may have arisen over the fact that V.O.Kovalevsky's translation of "The Variation of Plants and Animals under Domestication" was given the title Origin of Species. (See Antonvich, Charl'z Darvin i ego teoriia, pp. 234-40.)

9. Darvin, Charl'z. Proiskhozhdenie vidov.

10. Ibid. Back cover.

11. Timiriazev, "Probuzhdenie estestvoznaniia," p. 18.

12. Two articles by Huxley were published in the Westminster Review in 1860; the first appeared in the January number in the science review section; the second appeared in the April number and was a much longer article, some 40 pages compared to the January review of 5 pages. I have been unable to trace which of these was the one translated into Russian since the Russian review is not in England and I have not been able to find exact page references. However, since their content was very similar they would both have had the same kind of impact and influence.

13. Stecher and Klavins, "Darwin and the Moscow Naturalists," p. 158.

14. Kutorga, S.S. "Darvin i ego teoriia obrazovaniia vidov," Biblioteka dlia Chteniia. 1861, nos. 11 and 12, quoted in Alekeseev ed., Khrestomatiia, p. 637; Antonovich, Charl'z Darvin i ego teoriia, pp. 235-6.

15. Antonovich, Charl'z Darvin i ego teoriia, pp. 235-6.

16. Strakhov. "Durnye Priznaki".

17. Mechnikov. "Neskol'ko slov o sovremennoi teorii proiskhozhdeniia vidov," in Izbrannye raboty po Darvinizmu, pp. 155-64.

18. Rachinskii, "Tsvety i Nasekomye".

19. Ibid. p. 392.

20. Timiriazev. "Kniga Darvina. Eyo kritiki i Kommentatory". In the last part of this article Timiriazev wrote a footnote saying that he would deal with the Commentators on Darwin's theory in another article. However, it is not clear if he ever did. I have been unable to find any reference to another article on this subject and by the third edition this footnote had been removed.

21. Pisarev. "Progres v mire zhivotnykh i rastenii,". First printed in Russkoe Slovo, 1864, books 4-8.

22. This article will be described in some detail as I think it is fair to take it as a typical example of the treatment Darwin's theory received at this time in Russia, and it is also one of the few early articles I have been able to read in the original.

23. Timiriazev, "Kniga Darvina," Ot. Zap., no. 8, pp. 911-2.

24. Ibid. Ot. Zap., no. 10, pp. 662-3.

25. Ibid. p. 671.

26. Ibid. p. 684.

27. Ibid. p. 656.

28. Even after 1864 the word 'otbor' was not completely adopted. For example Mechnikov uses 'podbor'. Prior to and around that date various words were used: Pisarev used 'vybor' (choice); Kutorga used 'otbornost' (an old-fashioned version of 'otbor').

29. Timiriazev, "Kniga Darvina," Ot. Zap., no. 10, p.668.

30. Darwin, Origin, 6th edn., p. 403; Timiriazev, "Kniga Darvina", Ot. Zap., no. 12, p. 882.

31. The 1882 edition contained a reprint of the 1864 article as well as the text of a lecture given by Timiriazev in 1878 entitled "Charles Darwin as a type of scientist". Later editions also contained articles published by Timiriazev in his polemic with Strakhov in the 1880s as well as other articles.

32. Timiriazev, Charl'z Darvin i ego Uchenie, 1894. p. 8.

33. Pisarev, Selected Philosophical Social and Political Essays, p. 388-9; 490.

34. Ibid. p. 439.

35. Ibid. pp. 439-44.

36. This was by no means the total number. In a footnote to an essay published in Sovremennik, 1864, Antonovich mentions an essay he had done in the previous issue of the review on Darwin entitled "The Theory of the origin of species in the animal kingdom". (See Antonovich, Izbrannye Stat'i, p. 539.) Antonovich also refers to important articles on the Origin of Species appearing in Sovremennik, Otechestvennye Zapiski and Biblioteka dlia Chteniia. (See Antonovich, Charl'z Darvin i ego teoriia, p. 239.)

37. Müller, Fritz. Für Darwin. Germany, 1864.

38. Müller, F, Facts and Arguments for Darwin, p. 5.

39. According to Ratner and Shafronovskii (Priroda, p. 114) the Russian translation was entitled "Darwin's Theory on the Origin of Species. A popular exposition". I could find no trace of this Russian edition or of the original German one, but in Poggendorff (vol. III, 1896-8) there is a reference to two works by Dr. F. Rolle (a German geologist 1827-87) concerning Darwin's

theory 'Darwin's Lehre und ihre Anwendung auf die Schopfungsgeschichte', 1862, 2nd ed., ~~p.~~ 274ff; and 'Der Mensche im Lichte der Darwinische Lehre', 1865. Presumably the Russian translation was of his earlier work.

40. Darwin, Descent of Man, p. 3.

41. Pisarev, Selected Philosophical Social and Political Essays, pp. 455, 493.

42. Quoted in Mechnikov, Izbrannye raboty po Darvinizmu, p. 158.

43. Quatrefages de Bréau, Jean Louis Armand de (1810-92) Occupied chair of anatomy in ethnology at Muséum National.

44. Quatrefages, "Estestvennaia istoriia cheloveka," pp. 89-90.

45. Zaitsev, V.A. (d. 1882) collaborator on review Russian Word.

46. Even'ev-Maksimov and Tizengauzen, Poslednie gody 'Sovremennika', p. 302; Gaissinovich, "Biolog-Shestidesiatnik N.D. Nozhin," p. 388.

47. This approach was partially necessitated by the fact that these reviews were readily available in London.

48. Antonovich, Charl'z Darvin i ego teoriia, p. 239.

49. Rachinsky, Review of Kauffman's Moskovskaia Flora, p. 614.

50. Grove, Sir William Robert, (1811-96) Physicist.

51. "Uspekhi estestvoznaniia godichnoe sobranie Britanskogo Obshchestva Spospeshestvovaniia Nauk," pp. 35-6.

52. Ibid. p. 32.

53. "S'ezd Britanskikh Estestvoispytatelei," pp. 349-50.

54. Florovskii, Puti Russkogo Bogosloviia, p. 336.

55. Efremov, compiler, Ukazatel' k Pravoslavnomu Obozreniu 1860-1870.

56. See p. 61-2.

57. Timiriazev, "Probuzhdenie estestvoznaniia," p. 18.

58. Knizhnii Vestnik, 1866, no. 7, p. 173, quoted in Gaissinovich, "Biolog shesti-des'atnik N.D. Nozhin," p. 391.

59. Kniazev, "Izbranie Ch. Darvina," p. 117.

60. Ibid. p. 117.

61. Ibid. p. 117.

62. This paper was the same as the article referred to previously on p. 150.

63. Davison, Thomas (1817-85) English Palaeontologist.

64. Quoted in Stecher and Klavins, "Darwin and the Moscow Naturalists," p. 157. The diploma alluded to in the letter has not been found.

65. See Darwin, Life and Letters, vol. III, pp. 373-6.

66. Ratner and Shafronovskii, "Pervye perevody", p. 115; Antonovich, Charl'z Darvin i ego teoriia, pp. 252-340.

67. Timiriazev, Charl'z Darvin i ego uchenie, 1898, p. 11.

68. Ibid. pp. 11-12.

69. For further details see Chapters VI and VII.

70. Timiriazev, Charl'z Darvin i ego uchenie, 1898, pp. 221-2.

71. Kniazev, "Izbranie Ch. Darvina", p. 120.

72. Prilozhenie No. 4 k "Protokolam VII S'ezda russkikh estestvoispytatelei i vrachei". Odessa, 1883, pp. 1-2. Quoted in Bliakher, "Ch. Darvin i Brat'ia Kovalevskie", p. 70.

73. Platonov, K.A.Timiriazev, p. 35.

74. Ibid. p. 33; Timiriazev, Charl's Darvin i ego uchenie, 1937, p. 22.

75. It was closed down in 1892 and then reopened as the Moscow Agricultural Institute in 1894. Timiriazev was not included on the teaching staff after the reopening. See Platonov, K.A.Timiriazev, p. 37.

76. Timiriazev, Charl'z Darvin i ego uchenie, 1937, p. 264.

77. Bliakher, "Charl'z Darvin i brat'ia Kovalevskie", p. 70.

78. Mechnikov, Izbrannye raboty po Darvinizmu, p. 377.

CHAPTER V

1. Darwin, Origin of Species, 1st edn., p.2.
2. Ibid. p. 53. In 6th edition, p. 45, 1st part changed slightly to make it more generalised.
3. See pp. 230-33.
4. In the Origin of Species Darwin devoted Chapters 6 and 7 specifically to difficulties of the theory, and in other chapters devoted to subjects such as geology, hybridism etc. he pointed out facts inconsistent with his theory as well as those that confirmed it.
5. See appendix.
6. Timiriazev, Razvitie estestvoznaniia, p. 30.
7. According to the Soviet Encyclopaedia the station was opened in 1871 after a resolution had been passed by the 2nd Congress of Scientists and Doctors, and that in 1892 the Academy of Sciences took over the administration and with Kovalevsky as the head the station developed into an important biological centre. In the Andreevsky Encyclopaedia there is no reference to the biological station and so it appears that the official opening of the station was 1892.
8. Darwin, Origin, 1st edn., p. 381.
9. This work was presented in three main papers: Kovalevsky's master's thesis presented in 1865 on the "History of Development of the Amphioxus"; this study was developed in a monograph printed in 1867 in the Mémoires of the Academy of Sciences "Le

developpement de l'Amphioxus Lanceolatus" (also published in Archives Sci. Phys. Nat., 1866, XXVII, pp. 193-5 and in Ann. Mag. Nat. Hist., 1867, XIX, pp. 69-70); the third was a monograph on the Ascidian "Entwickelungsgeschichte der einfachen Ascidien", printed in the Memoires of the Academy of Sciences, 1867, X (no. 15) and in the Quarterly Journal of the Microscopic Society, 1870, X, pp. 459-69.

10. Kovalevsky, Izbrannye raboty, pp. 41-2.

11. Ibid. pp. 25, 46.

12. Ibid. pp. 25-6.

13. Ibid. p. 26.

14. Ibid. pp. 49-54.

15. Huxley, Lectures on the elements of comparative anatomy, pp. 59-61.

16. Kovalevsky, Izbrannye raboty, pp. 56-9.

17. Darwin, Descent of Man, pp. 159-60.

18. Arkhiv AN SSSR, f. 446, op.2, no. 309, 1 13-14. Quoted in Bliakher, "Ch. Darvin i brat'ia Kovalevskie", pp. 70-1.

19. For example over the question of priority with Haeckel's theory of biogenesis. See p. 279.

20. Romanovich-Slovatinsky, A.V. "Moia zhiz'n v akademicheskaia deiatel'nost' . . . Vestnik Evropy, 1903, aprel', p. 541. Quoted by Gaissinovich, "Biolog-shestidesiatnik N.D.Nozhin," p. 380.

21. Von Baer. "Entwickelt sich die Larve der Einfachen Ascidien in der ersten Zeit nach dem Typus der Wirbelthiere?" For Von Baer's other criticisms of Darwin's theory see pp. 255-9.

22. Radl, History of Biological Theories, p. 60.

23. Ibid. pp. 213-7.

24. According to his biography by Anuchin, but Alexander Kovalevsky, in a letter to Bogdanov, (written on the 17th April 1887 stated quite decisively that this was untrue (Perepiska A.D.Kovalevskogo, p. 132).

25. The word Hyopotimidae is as it was printed in the Royal Society Transactions. According to Kovalevsky they were an extinct family of the Ungulates, or hoofed mammals.

26. Kovalevsky, "On the osteology of the Hyopotimidae", p. 20.

27. Ibid. p. 27.

28. Ibid. pp. 21-2.

29. It was also printed in Russian in 1873. See Anuchin, p. 280.

30. Kovalevsky, Sobranie nauchnykh trudov, vol. II, p. 11.

31. Ibid. p. 11.

32. See Encyclopaedia Britannica.

33. Timiriazev, Nauka i Demokratiia, p. 102.

34. Timiriazev, Razvitie estestvoznaniia, pp. 27-9.

35. Fiziologiia obydennoi zhizni, Moscow, 1861-2.

36. "Antropologicheskii printsip v filosofii". Sovremennik, 1860, nos. 4 and 5.

37. Timiriazev, "Probuzhdenie estestvoznaniia", p. 20.

38. Sechenov. "Refleksy golovnogo mozga". First appeared in Medtsinskii Vestnik in 1863, the censor having refused to allow it to appear in Sovremennik. When

it came out in book form in 1866 the authorities tried unsuccessfully to ban it. (See Bol'shaia Sov. Enc., 1955, vol. XXXVIII, pp. 624-5).

39. There are a number of references to this tendency of the sciences in Russia in the 1860s: Rachinsky, review of Kauffman's 'Moskovskaia Flora' pp. 614; Antonovich, Charl'z Darvin i ego teoriia, pp. 233-4; Timiriazev, "Razvitiea estestvoznaniia", p. 30.

40. Radl, History of Biological Theories, pp. 86-90.

41. Timiriazev, Probuzhdenie estestvoznaniia, pp. 16-17.

42. Radl, History of Biological Theories, pp. 198-207; Darwin, Origin, 1st edn., p. 3.

43. Beketov, Uchebnik botaniki, 1883, p. 501; quoted in Alekseev edn., Khrestomatiia, p. 648.

44. Brockhaus-Efron, vol. XXXIII, 1901, p. 182.

45. Levakovskii, "K voprosu o vytesnenii odnykh rastenii drugimi".

46. Ibid. pt. II, p. 31.

CHAPTER VI

1. Vorzimmer, "Charles Darwin and Blending Inheritance", pp. 371-90.

2. Darwin, Origin, 1st edn., p. 395.

3. Ibid. p. 400.

4. Darwin, Origin, 6th edn., p. 395. There are also many other references for the same point; among others: Origin, 6th edn., p. 5; Variation of Animals, vol. 2, 2nd edn., 1885, pp. 280-1, 345.

5. Darwin, Origin, 1st edn., p. 162.

6. Ibid.

7. Darwin, Descent of Man, p. 61.

8. The name neo-Darwinist was a slight misnomer in as far as Darwin himself was concerned, since, especially towards the end of his life, he occupied a position between the two schools and saw both natural selection and the action of the environment as agents of the modification of species.

9. Wallace, Alfred Russel (1823-1913) Arrived at the same theory of evolution through natural selection independent of Darwin.

10. Weismann, August (1834-1914) German biologist. His greatest contribution was the theory of the continuity of the germ plasm.

11. This isolation theory was first put forward by Moritz Wagner (1813-87) a German naturalist, in 1868 and was later taken up by two English scientists, G.J.Romanes (1848-94) and J.T.Gulick.

12. Leading members of this trend were:-
Gaston Bonnier (1853-1922) botanist, Alfred Giard (1846-1908) biologist, Frédéric Houssay (1860-1920) biologist, and Edward Perrier (1844-1921) naturalist, in France; and Edward Drinker Cope (1840-97) zoologist, palaeontologist and Henry Fairfield Osborn (1857-1935) geologist and palaeontologist in America.

13. The theory of heterogenous origin was first put forward in 1864 by Rudolph Albert von Kolliker (1817-1905), a Swiss embryologist and histologist.

14. Alekseev ed., Khrestomatiia, p. 637.

15. Ibid. pp. 164-7.

16. Mechnikov, Izbrannye Raboty po Darvinizmu, p. 164.

17. Ibid.

18. Brockhaus-Efron, vol. X, 1893, p. 77.

19. Brockhaus-Efron, vol. X, 1893, p. 77.

20. Brockhaus-Efron, vol. XXXII, 1900, p. 786.

21. Among the essays that he wrote on the natural sciences were "On the method of the natural sciences and its significance for general education" (1865), "The world as a totality, characteristics taken from the science of nature" (1892) and "On the basic concepts of psychology and physiology" (1894).

22. Strakhov, "Spor iz-za knig N.Y.Danilevskogo", p. 190.

23. "Polnoe oproverzhenie Darvinizma" first appeared in Russkii Vestnik, 1887, nos. 1 and 2. Reprinted later in a collection of essays: Bor'ba s zapadom v nashei literature.

24. "Oprovergnut li Darvinizm?" was first printed in Russkaia Mysl', 1887, nos. 5 and 6; reprinted in Charl'z Darvin i ego Uchenie, 3rd edn., 1894, and some other later editions.

25. Tolstovskii Musei, p. 350.

26. "Vsegdashnaia oshibka darvinistov" was first printed in Russkii Vestnik 1887, nos. 11 and 12; it was reprinted in Bor'ba s zapadom v nashei literature.

27. "Bezsil'naia zloba antidarvinstav" was first printed in Russkaia Mysl', 1889, nos. 5,6 and 7; reprinted in Charl'z Darvin i ego Uchenie.

28. Timiriazev, Charl'z Darvin i ego uchenie, 4th edn., p. 297-302.

29. Danilevsky, Darvinism, vol. I, part 2, pp. 459-64.

30. Brookhaus-Efron, vol. X, 1893, p. 77.

31. <u>Nägeli, Karl Wilhelm von</u> (1817-91) Swiss botanist.

32. Timiriazev, Ch. Darvin i ego uchenie, 4th edn., pp. 232-43.

33. Ibid. pp. 342-6.

34. Ibid. p. 347.

35. Strakhov, Bor'ba s zapadom v nashei literature, p. 406.

36. Timiriazev, Ch. Darvin i ego uchenie, 4th edn., pp. 253-5.

37. In a letter to Tolstoy Strakhov wrote: ". . . I am forced not to overstep the limits established by N.Y.Danilevsky . . ." Tolstovskii Musei, p. 361.

38. See appendix.

39. Timiriazev, Ch. Darvin i ego uchenie, 1937, p. 97.

40. Ibid. pp. 54-9.

41. Ibid. pp. 314-5.

42. Timiriazev, Ch. Darvin i ego uchenie, 4th edn., p. 330.

43. Timiriazev, Ch. Darvin i ego uchenie, 1937, pp. 265-8, 282-9.

44. Ibid. p. 26.

45. Ibid. p. 26.

46. Ibid. pp. 259-60, 293.

47. Ibid. p. 293.

48. See pp. 99-100, 110.

49. Darwin, Life and Letters, vol. II, pp. 329-30.

50. See p. 171.

51. Baer, Avtobiographiia, pp. 458-9.

52. Ibid. p. 510.

53. See p. 201.

54. Baer, Reden, vol. I, 1864, p. 37.

55. Ibid. vol. III, 1873, pp. v-vi. Translated by C.H.Lewes.

56. Brockhaus-Efron, vol. XX, 1897, pp. 641-9.

57. Menzbir, "Glavneishie predstaviteli darvinisma v zapadnoi evrope, August Weismann".

58. Beketov, "Garmoniia v prirode", p. 542.

59. Beketov, Geographiia rastenii, 1896, p. 7; quoted in Alekseev, edn., Khrestomatiia, p. 646.

60. Zvorykin edm., Biographicheskii slovar' deiatelei estestvoznaniia i tekhniki, vol. I, p. 53.

61. Alekseev edm., Khrestomatiia, pp. 642-8.

62. Mechnikov, "Zadachi sovremennoi biologii", p. 762.

63. Ibid. pp. 762-4.

64. Mechnikov, O Darvinizme, p. 179.

65. Ibid. pp. 179-80.

66. Darvin, Pamiati Darvina, pp. 115-6.

67. Sechenov, Izbrannye proizvedeniia, vol. I, p. 533.

68. Shmankevich, V.I. "Nekotorye rakoobraznye soliano-ozernykh i presnykh vod i otnoshenie ikh k srede", Zapiski Novorossiiskogo obshchestva estestvoispytatelei, vol. III, vyp. 2, 1875.

69. Michurin, Selected works, p. 11.

70. Ibid. p. 24.

71. Bol'shaia Sovetskaia Orcyclopedia, 1938, vol. XXXIX, p. 535.

72. Korzhinskii, "Geterogenezis i evolutsiia," p. 2.

73. Ibid. p. 2.

74. Ibid. pp. 73-87.

75. See p. 181.

76. Timiriazev, Ch. Darvin i ego uchenie, 1937, p. 264.

77. Darwin, Origin, 6th edn., pp. 188-9.

78. Knizhny Vestnik, 1866, no. 7, p. 175; quoted in Gaissinovich, Biologshestidesiatnik N.D. Nozhin, pp. 391-2.

79. Ibid.

80. This school was called the Russian school of subjective sociology, more details about it are given in Chapter VII.

81. Kropotkin, Mutual Aid, p. 10.

82. Timiriazev, Ch. Darvin i ego uchenie, 1937, p. 101.

83. Ibid. p. 103.

84. For example Menzbir, see Darvinizm v biologii i blizkikh k nei naukakh, pp. 3-40.

85. See Chapter VII for more detailed discussion.

86. Mechnikov, "Neskol'ko slov o sovremennoi teorii proiskhozhdeniia vidov (1863); "Zadachi sovremennoi biologii" (1873); "Ocherk voprosa o proiskhozhdenii vidov" (1876); "Bor'ba za sushchestvovanie v obshirnom smysle" (1878). These four essays form the basis for the following general exposition of his ideas. See also appendix for excerpt from "Ocherk voprosa".

87. Antonovich, Ch. Darvin i ego teoriia, p. 240.

88. This idea had first been put forward by Fritz Muller in relation to Crustacea in his work Fur Darwin. It was later developed into a general law by Haeckel.

89. There was no critical evidence to support this hypothesis. See Gavin de Beer, "Darwin and Embryology" in a Century of Darwin, p. 158-9.

90. Mechnikov, Izbrannye raboty po Darvinizmu, pp. 193-7.

CHAPTER VII

1. According to the Index of the Pravoslavnoe Obozrenie for the period 1860-1870; see also p. 167.

2. The only review I could personally check was the Khristianskie Drevnosti i Arkheologiia which had nothing concerning evolution. However, since I have found no mention of any religious attacks or criticisms either in contemporary or later references to the reception of the theory of evolution, I think it is justifiable to assume that there were no direct criticisms or comment of any significance from the part of the church.

3. Kudriavtsev, "O pervonachal'nom proiskhozhdenii na zemle roda chelovecheskogo".

4. According to the index for the period 1860 to 1870.

5. Quatrefages, "Estestvennaia istoriia cheloveka; edinstvo roda chelovecheskogo", p. 99.

6. Yurkevich, "Iz nauka o chelovecheskom dukhe", p. 27.

7. Strakhov, "Durnye priznaki", p. 164.

8. "Naturalist Wallace i ego Russkie perevodchiki".

9. Lindeman, Karl Eduardovich (fl. 1875-80) Entomologist, zoologist, professor at Petrovskii Agricultural Academy.

10. See Chapter V, note 39.

11. Masaryk, Špirit of Russia, vol. II, p. 5.

12. Ibid.

13. See Granat, eds., Istoriia Rossii v XIX veke, vol. IV, pp. 252-3; there is a quotation here from Moleschott's Der Kreislauf des Lebens:- "The features of our face, and the thoughts of our brain have the same geography as plants."

14. Yurkevich, "Iz nauki o chelovecheskom dukhe", vol. XXXII, pp. 91-3.

15. Ibid. Vol. XXXIII, p. 33.

16. Yurkevich, "Yazyk fiziologov i psikhologov".

17. Ibid. pp. 666-7; 703-4.

18. See Billington, The Icon and the Axe, p. 748. The piece quoted from Sechenov (p. 265-6) shows that his ideas and those of Chernyshevsky were very close,

19. Kavelin, Konstantin Dmitrievich (1818-85) Russian historian.

20. See pp. 24-27.

21. Masaryk, Spirit of Russia, vol. II, p. 6.

22. "Po povodu polemiki iz-za stat'i g. Yurkevicha", pp. 89-97.

23. Quoted in Florovskii, "Puti russkogo bogosloviia," p. 332.

24. Pravoslavnoe Obozrenie, 1860, vol. III, p. 114.

25. Kudriavtsev, "O pervonachal'nom proiskhozhdenii na zemre roda chelovecheskogo," p. 173.

26. Yurkevich, "Iz nauki o chelovecheskom dukhe," p. 87.

27. See p. 286.

28. I have tried to trace the original of this declaration but without success. Nevertheless the comment by the editor of the Russkii Vestnik does not lose its validity for the Russian situation.

29. Pravoslavnoe Obozrenie, 1865, vol. XVI, yanv., pp. 58-9.

30. Brockhaus-Efron, 1900-1, vol. XXXI, pp. 783-5.

31. Tolstovskii Muzei, p. 31.

32. Ibid. p. 378.

33. Danilevsky, Darvinizm, vol. I, part 2, p. 481.

34. Ibid. p. 478.

35. Ibid. p. 479.

36. Ibid. p. 523.

37. Strakhov, Bor'ba s zapadom, p. 337.

38. Lopatin, Lev Mikhailovich (1855-1920) Philosopher.

39. Quoted in Florovskii, Puti Russkogo bogosloviia, p. 308.

40. Masaryk, The Spirit of Russia, vol. II, pp. 269-70.

41. Dostoevsky, Letters from the underworld, p. 17.

42. Tolstoy, O nauke i literature, p. 34.

43. Obolensky, Leonid Egorovich (b. 1845) Philosopher, publicist and critic.

44. Tolstoy, Pis'ma 1848-1910, vol. II, pp. 94-5.

45. Tolstovskii Muzei, p. 424.

46. It was a translation of G.H.Lewes,'Comte's Philosophy of the Sciences' and J.S.Mill, "Aug. Comte and Positivism'.

47. See p. 27.

48. Lavrov, Istoricheskie pis'ma, p. 10.

49. Menzbir, Darvinizm v biologii, p. 50.

50. Hecker, Russian sociology, p. 173.

51. Lavrov, Stat'i, pp. 200-1.

52. Mikhailovsky, Sochineniia, 1894, p. 430.

53. Brockhaus-Efron, 1904, vol.XLI, pp. 287-8.

54. Hecker, Russian sociology, p. 156.

55. Kropotkin, Mutual aid, p. 10.

56. Ibid. p. 13.

57. Darvin, Pamiati Darvina, pp. 134-5.

58. See pp. 272-5.

59. Spencer, First principles, London, 1910, p.321; quoted in Fothergill, Historical aspects, pp. 104-5.

60. Merz commented on Spencer's formulation in the following way: ". . . the formula of Spencer enabled him to group a vast number of physical and biological phenomena and processes into an intelligible synthetical view, but it did not permit him clearly to bring out what is the distinguishing characteristic of progress as compared with mere change." (See Merz, A history of European thought, vol. IV, p. 529.)

61. Darwin, Descent of Man, pp. 127-145, for example.

62. Mikhailovsky, Sochineniia, 1894, p. 430.

63. Lavrov, Istoricheskie pis'ma, p. 262.

64. Chernyshevsky, Polnoe sobranie sochinenii, vol. X, p. 923.

65. Lavrov, Istoricheskie pis'ma, pp. 4-5.

66. <u>Royer, Clémence</u> (1830-1902) Philosopher and scientist. Made first French translation of Origin of Species.

67. <u>Renan, Ernest</u> (1823-92) French writer.

68. Mikhailovsky, Sochineniia, 1897, vol. V, p. 632.

69. Ibid. p. 636.

70. Ibid. vol. II, p. 204.

71. "Smert' Darvina", first printed May, 1882.

72. Mikhailovsky, Sochineniia, 1897, vol. V, p. 635.

73. Chernyshevsky, Polnoe sobranie sochinenii, vol. XV, p. 687.

74. Ibid. Vol. X, pp. 738-9.

75. Billington, The Icon and the Axe, p. 397.

76. I have so far not found any other references to this fact, but it may well have been true; this interpretation of Darwinism as the survival of the fittest race or nation was also present in Prussia at the time of the Franco-Prussian war.

77. Quoted in Darwin, Pamiati Darvina, p. 136.

78. Ibid.

79. Timiriazev, "Probuzhdenie estestvoznaniia", p. 27.

80. Steinberg, Dostoevsky, p. 96.

81. Dostoevsky, Letters from the Underworld, p. 16.

82. Chekhov, Sobranie sochinenii, vol. XI, pp. 19,153.

83. See p. 245.

84. Chekhov, Three plays, p. 107.

CONCLUSION

1. Quoted in Carr, E.H. What is History? Pelican, London, 1964. p. 58.
2. Quoted in Medawar, P. The Art of the Soluble. London, 1967. p. 148.
3. Quoted in O'Brien, John A. Evolution and Religion, 1932. p. 103.

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BIOGRAPHICAL DATA

(The scientists used for the
Survey of the Royal Society Catalogue,
referred to in the text, are marked with an asterisk)

Arnol'dy, Feodor Karlovich (b. 1819) Forestry expert.

Antonovich, Maxim Alekseevich (1835-1918) Literary critic and geologist. Contributed to review Sovremennik in early 1860s. In 1871 discovered secondary devonian layer on shores of Western Dvina.

Antonsky, Anton Antonovich (d. 1848) Natural scientist. Professor and rector at Moscow university

*Anuchin, Dmitri (1843-1923) Anthropologist, ethnograph~~ist~~er, archaeologist and geographer. 1871-4 secretary of Society for the Acclimatisation of Animals and Plants. 1884 lecturer in geography and ethnography at Moscow university. Supporter of theory of evolution.

*Babukhin, Alexander Ivanovich (1835-91) Histologist and physiologist. 1865 professor at Moscow university. Main work on electrical organs of fish.

*Baer, Karl Ernst von (1792-1876) Embryologist. See pp. 98; 200.

Basov, V.A. (1812-1879) Assistant to Filomafitsky; later professor of surgery at University; did experiments on digestion and blood transfusion.

*Beketov, Andrei Nikolaevich (1825-1902) Botanist. 1861 professor at St. Petersburg university. The botanical garden was built for the university on his initiative.

*Bekhterov, Vladimir Mikhailovich (1857-1927) Physiologist, neuropathologist and psychiatrist. 1885 professor of psychiatry at Kazan.

Belinsky, Vissarion Grigorevich (1810-48) Leading literary critic and polemicist. Member of radical intelligentsia and of westerner trend.

Bogdanov, Anatolii Petrovich (1834-96) Anthropologist and zoologist. 1867 professor at Moscow university. Influenced by Roullier. Helped to organise Society of Lovers of Nature, the Zoological, Ethnographical, Anthropological and Polytechnical Museums, etc.

*Bogdanov, Modest Nikolaevich (1841-88) Zoologist and explorer. 1881 professor at St. Petersburg. Main work on birds of Caucasus.

*Borodin, Ivan Parfon'evich (1847-1930) Botanist. 1880 professor at St. Petersburg university. 1902 academician. Main work on plant respiration, chlorophyll, plant anatomy, crystalline deposits in cells.

*Borshchev, Ilia Grigor'evich (1833-78) Botanist and chemist. 1868 professor at Kiev university.

Borzenkov, Yakov Andreevich '1825-83) Professor of comparative anatomy and physiology at Moscow university. Student of Roullier.

*Brandt, Alexander (b. 1844) Physiologist. Professor of zoology at Kharkov.

*Brandt, Johann Friedrich (1802-79) Zoologist and palaeontologist. Educated in Germany. 1831 went to Russia; 1833 academician; 1857-69 professor of Medical-Surgical Academy in St. Petersburg.

Butlerov, Alexander Mikhailovich (1828-86) Famous chemist. Student of Zinin. 1858 professor of chemistry at Kazan university. 1859 invited to Moscow university where he developed department of organic chemistry. Academician.

*Chernyshev, Feodosii Nikolaevich (1856-1914) Geologist and palaeontologist.

Chernyshevsky, Nikolai Gavrilovich (1828-89) Famous writer, literary critic and polemicist. Leading member of radical intelligentsia and westerner. 1855-62 editor of Sovremennik. 1862 arrested and exiled to Siberia. He was only allowed to return in 1883.

*Chistiakov, Ivan D. (1843-77) Botanist. Taught in Moscow university. 1874 was first to describe mitosis/karyokinesis of plant cells. Main research into embryology and cytology of plants.

Danilevsky, N. Yakovlich (1822-85) Zoologist and slavophil. See pp. 236-7.

Diadkovsky, Iustin Evdokimovich (1784-1841) Therapeutist. 1831-36 lectured in Moscow university but dismissed for his materialist view point.

Dvigubsky, Ivan Alekseevich (1771-1839) Naturalist. 1798 lecturer and 1807 professor at Moscow university. Wide interests - entomology, chemical technology, first Russian textbook on physics, first Russian guide to wild plants of Moscow area, first attempt at full description of Russian fauna.

Eichwald, Eduard Ivanovich (1795-1876) Naturalist. Corresponding member of the Academy of Sciences. Professor at Dorpat (1821-3), Kazan (1823-9), Vilna (1829-38) and St. Petersburg Medical-Surgical Academy (1838-51); also read palaeontology at St. Petersburg Mining Institute (39-55). Works on mineralogy, geology, palaeontology (first one in Russian), botany and textbook of zoology.

Engelhardt, A.N. (1828-93) Scientist, farmer and publicist. 1866-9 professor of chemistry at St. Petersburg Agricultural Institute. From 1870 worked on estate and tried to improve agricultural methods.

*Famintsyn, Andrei Sergeevich (1835-1918) Plant physiologist. Academician. 1867 lecturer and 1872 professor in department of plant physiology at St. Petersburg. 1867 together with O.V.Baranetskii showed the complicated nature of lichens and was first to establish their relationship with the free living water plants.

Filomafitsky, Aleksei Matveevich (1807-49) Physiologist. 1835 professor at Moscow university. Was one of the first representatives of the experimental trend in physiology in Russia. 1836-40 published 3-volumed 'Physiology, a guide for students'.

Fischer von Waldheim, Grigorii Ivanovich (1771-1833) Naturalist. German by nationality. 1804 invited to Moscow university. 1805 corresponding member of Academy of Sciences. Helped found Moscow Society of Naturalists. Varied work on palaeontology, geology, entomology etc.

Ganin, Mitrofan Stepanovich (b. 1839) Zoologist. 1869 lecturer at Warsaw on comparative anatomy, histology, embryology. (Mentioned as a critic of Weismann).

Glebov, Ivan Timofeevich (1806-84) Physiologist and anatomist. 1836, professor at Moscow Medical-Surgical Academy; 1842, professor at Moscow university. Introduced a number of reforms into Academy.

Golubakh, L.F. (1793-1824) Botanist. Began to publish a description of plants used in medicine in Russian; studied Moscow flora.

*Gorozhankin, Ivan Nikolaevich (1848-1904) Plant morphologist. 1881 professor at Moscow university. Established comparative morphological trend in Russian botany with aim to find out relationships between plants.

Gorianinov, Pavel Fedorovich (1796-1865) Naturalist and doctor. 1825 lecturer and 1832 professor at St. Petersburg Medical-Surgical Academy. Was naturalist in spirit of Oken, developed idea of unity of nature; advocated evolution by means of a vital force.

Helmerson, Grigorii Petrovich (1803-85) Geologist. Attached to corps of mining engineers and also worked in the geological museum of the Academy. Undertook number of geological expeditions.

Herzen, Alexander Ivanovich (1812-70) Leading member of Radical Intelligentsia. See p. 21-2.

Hoffman, G.F. (1766-1826) Botanist. 1804 invited to Moscow university. 1817, also professor at Moscow Medical-Surgical Academy.

Hoffman, E.I. (d. 1867) Geologist. 1857 finished St. Petersburg university and went abroad.

1865 assistant lecturer on newly formed geological faculty at St. Petersburg university.

Hoffman, E.K. (1801-71) Geologist. 1845-63 professor of mineralogy at St. Petersburg university. Made number of geological expeditions. Most of work written in German.

Kaidanov, Y.K. (1779-1855) Professor in Medical-Surgical Academy; follower of naturphilosophie.

Katkov, Mikhail Nikiforovich (1818-87) Famous publicist. Editor of Russian Herald. Member of conservative wing of intelligentsia in 1860s.

*Kauffman, Nicolas (1834-70) Botanist. 1860 teaching at Moscow university. Main work 'Moscow Flora'.

*Kessler, Karl Fedorovich (1815-81) Zoologist. 1845-62 professor at Kiev university; 1862 professor at St. Petersburg. Main work on Russian fauna, especially birds and fish. Helped to organise Congresses of Russian Scientists and Doctors.

Komarov, Vladimir Leontievich (1869-1945) Botanist, geographer and traveller. Studied at St. Petersburg university in 1890s. Convinced evolutionist.

*Korotnev, Aleksander Alekseevich (1851-1915) Zoologist. 1887-1915 professor at Kiev.

Korzhinskii, Sergei Ivanovich (1861-1900) Botanist, systematist, phyto-geographer. 1888-92 professor at Tomsk university. 1893 adjunct and 1897 associate academician of Academy of Sciences. Developed theory of heterogenesis with respect to evolution.

*Kovalevsky, Aleksander Onufrievich (1840-1901) Evolutionary embryologist. See pp. 190-1.

*Kovalevsky, Nicolas (1840-91) Physiologist. 1865 professor at Kazan.

*Kovalevsky, Vladimir Onufrievich (1828-92) Evolutionary palaeontologist. See pp. 202-3.

Kropotkin, Prince Peter (1842-1921) Anarchist and social philosopher. Made important geographical and geological explorations of Siberia and Scandinavia. 1902 'Mutual Aid' theory of solidarity as principle of evolution and progress.

<u>Kudriavtsev, Victor Dmitrievich</u> (1828-92) Philosopher.

<u>Kutorga, Stepan Semeonovich</u> (1805-61) Naturalist. 1837 Professor at St. Petersburg university. Research into geology and palaeontology.

<u>Lavrov, Petr Lavrovich</u> (1823-1900) Philosopher and sociologist. Exiled at end of 1860s and escaped abroad, where he edited socialist publications in Russian.

*<u>Lesshaft, P.F.</u> (1837-1909) Pedagogue, anatomist and doctor. 1868-71 lecturer of physiological anatomy at Kazan; 1886-97 lecturer in anatomy at St. Petersburg university.

<u>Levakovsky, Ivan Fedorovich</u> (1828-93) Geologist. 1864 professor at Kharkov. Did a lot of practical geological work.

<u>Litke, F.P.</u> (1797-1882) Explorer and sailor. President of Academy of Sciences from 1864.

<u>Lovetsky, Aleksei Leontevich</u> (1787-1840) Doctor and naturalist. 1824 taught natural history at Moscow university. 1828 professor of mineralogy and agriculture at Medical-Surgical Academy and in 1833 moved to department of physiology and pathology.

<u>Maksimovich, M.A.</u> (1804-1873) Worked in Botanical Gardens of university; influenced by Oken and naturphilosophie; 1833 went to Kiev and changed his speciality to folklore.

*<u>Mechnikov, Elia Il'evich</u> (1845-1916) Evolutionary embryologist and pathologist. See pp. 198-9.

<u>Meder, P.I.</u> From 1797 read geognosy according to Werner in Mining College; opposed to catastrophic theory.

<u>Mendeleev, Dmitri Ivanovich</u> (1834-1907) Famous chemist. Founder of periodic system of elements.

<u>Michurin, Ivan Vladimirovich</u> (1855-1937) Experimental horticulturist. See pp. 266-7.

Middendorff, Alexander Fedorovich (1815-94) Natural scientist and explorer. Academician. Led Academy expeditions to Siberia and other parts of Russia.

Mikhailovsky, Nikolai Konstantinovich (1842-1904) Publicist and sociologist.

Nozhin, Nikolai Dmitrevich (1843-66) Talented zoologist and evolutionist.

*Ovsiannikov, Philip Vasilievich (1827-1906) Physiologist and histologist. 1863-92 professor at St. Petersburg university; 1864 academician.

Pallas, Peter Simon (1741-1811) Naturalist. German by nationality. 1767 invited to Russia by Academy of Sciences. Made number of expeditions and collected large amount of geological, botanical, ethnographical material etc. See p. 101.

Pander, Christian Ivanovich (1794-1865) Embryologist, palaeontologist and anatomist. 1821-17 worked in Academy of Sciences.

*Pavlov, Ivan Petrovich (1849-1936) Physiologist. Student of Sechenov. Famous for theory of reflexes.

Pavlov, Mikhail Grigorevich (1793-1840) Professor of physics, mineralogy and agriculture and doctor of medicine at Moscow university. One of first Russian followers of Schelling.

Pirogov, Nikolai Ivanovich (1810-81) Famous surgeon, doctor and teacher.

*Rachinsky, Sergei Alexandrovich (b. 1836) Botanist. 1859-67 professor at Moscow university. Translated 'Origin of Species' into Russian.

Radishchev, Alexander Nikolaevich (1749-1802) Writer. Father of Russian radical tradition. Famous for his book 'Journey from St. Petersburg to Moscow' which was an indirect attack on serfdom. He was exiled for it.

Renard, Karl Ivanovich (1809-86) Doctor of medicine. 1840-72 secretary, 1872-84 vice-president and 1884-6 president of the Moscow Society of Naturalists. Editor of its journals. Keeper of Moscow university zoological museum.

Roullier, Karl Frantsovich (1814-58) Zoologist and geologist. See p. 111.

*Ruprecht, Franz Joseph (1814-70) Botanist. German by nationality. 1839 went to Russia and worked in Academy of Sciences till end of life. Main work was study of Russian flora.

Schrenk, Leopold Ivanovich (1830-94) Zoologist. Academician. Main work on ethnography, anthropology and zoogeography.

*Sechenov, Ivan Mikhailovich (1829-1905) Physiologist. 1869 corresponding member and 1904 Hon. member of Academy of Sciences. See pp. 212-3.

Sevastianov, Alexander Fedorovich (1771-1824) Natural scientist, academician. Studied zoology, palaeontology and geology. Translated works of Humboldt, Linnaeus etc.

Severgin, Vasilii Mikhailovich (1765-1826) Mineralogist and chemist. Academician. Wrote number of works on mineralogy in Russian. Helped popularise sciences through the Technological Journal. Helped found Mineralogical Society in 1817.

*Severtsov, Nikolai Alekseevich (1827-85) Zoologist, zoogeographer and explorer. Studied at Moscow university. Made a number of journeys to Central Asia and published papers on the fauna, geography and geology of these places. Famous as the first Russian ecologist.

Shchurovskii, G.E. (1803-84) Geologist and populariser of the natural sciences. First professor of Geology and Mineralogy at Moscow university, where he occupied chair from 1835-84. Led geological expeditions to the Urals in 1840 and the Altai in 1844. Main works were on the geology of the Moscow Basin and the Caucasus.

Shikhovsky, Ivan Osipovich (1805-54) Botanist. 1840-54 professor at St. Petersburg university.

Shimkevich, Vladimir Mikhailovich (b. 1858) Zoologist. 1889 lecturer and 1895 professor at St. Petersburg university. Main work on arthropoda and coelenterata.

Sokolov, Dmitrii Ivanovich (1788-1852) Geologist. 1822-44 professor at St. Petersburg university; at the same time he taught in Mining Institute.

Steven, Christian Christianovich (1781-1863) Botanist and entomologist. Swedish by nationality. Studied at St. Petersburg Medical-Surgical Academy. Main works on flora of Crimea and Caucasus.

Strakhov, Nikolai Nikolaevich (1828-96) Writer and critic. See p. 238.

Straukh, Alexander Alexandrovich (1832-93) Zoologist. Academician.

Teriaev, A.M. (1767-1827) Professor of natural history and mineralogy in the St. Petersburg Pedagogical Institute and Medical-Surgical Academy; one of the founders of the Mineralogy Society in 1817.

*Timiriazev, Kliment Arkad'evich (1843-1920) Plant Physiologist. See pp. 154; 220-21.

*Trautschold, Herman Adol'fovich (1817-1902) German geologist. Lived in Russia 1857-88.

*Tsenkovsky, Lev Sem'onovich (1822-87) Botanist. Polish by nationality. Studied at St. Petersburg university. Professor in St. Petersburg (1854-62), Warsaw (1862-5), Odessa (1865-72) and Kharkov (1872) universities. One of founders of protistology and bacteriology.

Usov, Sergei Alekseevich (1827-86) Zoologist. 1861 lecturer and 1868 professor at Moscow university. Student of Roullier and influenced by him. 1858-9 editor of the Herald of the Natural Sciences.

Uvarov, Count Sergei Semenovich (1786-1855) 33-49 Minister of Education. 1818-55 President of Academy of Sciences.

Varnek, Nikolai Aleksandrovich (1821-76) Zoologist. 1852-60 professor of comparative anatomy and physiology at Moscow university.

Vellansky, D.M. (1773-1847) Professor of physiology and anatomy in Medical-Surgical academy; follower of Schelling and Oken; one of leaders of naturphilosophie in Russia.

*Voronin, Michael Stepanovich (1838-1903) Microbotanist. Academician (1898). He lived a lot of the time abroad and was not a professor at any university. Main work was into fungi.

*Wagner, Nikolai Petrovich (1829-1907) Zoologist. 1860-71 professor at Kazan; 1871 professor at St. Petersburg. Best known for his discovery of parthogenesis.

Wolff, Caspar Friedrich (1733-94) German embryologist. Invited to Russia by the Academy of Sciences in 1767.

Yakubovich, N.M. (1817-79) Histologist and physiologist. 1853 assistant professor at St. Petersburg Medical-Surgical Academy. Received Paris prize for work on central nervous system.

Yurkevich, Pamphil Danilovich (1827-74) Philosopher and theologian. Taught at Kiev and Moscow on philosophical faculties.

Yuzhakov, Sergei Nikolaevich (1849-1910) Publicist and sociologist.

Zalenskii, Vladimir Vladimirovich (b. 1847) Zoologist and embryologist. 1871 lecturer at Kazan; 1882 professor at Odessa. Main work on embryology of non-vertebrates.

Zheleznov, N.I. (1816-1877) Studied at St. Petersburg; influenced by Kutorga; interested in the morphology of plants and especially their embryology; lectured on agriculture in St. Petersburg; went to Moscow and worked with Roullier; 1857 elected academician.

<u>Zinin, Nikolai Nikolaevich</u> (1812-80) Chemist. Studied and taught at Kazan. 1847 invited to St. Petersburg as professor of chemistry at Medical-Surgical Academy. Academician. Most important work on benzene compounds.

APPENDIX I

SCIENCE SUBJECTS PROVIDED FOR BY UNIVERSITY CHARTERS*

FACULTY AND DEPARTMENTS

Charter		
1755	**Philosophical Faculty**	**Medical Faculty**
	Experimental and Theoretical Physics	1. Anatomy 2. Physical Chemistry 3. Natural History
1804	**Department of Physical and Mathematical Sciences**	**Department of Medical Sciences**
	1. Pure Mathematics 2. Applied Mathematics 3. Astronomy 4. Theoretical and Experimental Physics 5. Chemistry 6. Mineralogy and Agriculture. 7. Botany 8. Technology	1. Anatomy, Physiology 2. Pathology 3. Surgery 4. Midwifery 5. Veterinary Sciences 6. Pharmacy, etc.
1835	**Philosophy Faculty, 2nd Department**	**Medical Faculty**
	1. Pure and applied mathematics 2. Astronomy 3. Physics and Physical Geography 4. Chemistry 5. Mineralogy and Geognosy 6. Botany 7. Zoology 8. Technology, Forestry etc.	1. Anatomy 2. Physiology 3. 4. Clinical 5. Theoretical Surgery 6. Practical Surgery 7. Midwifery 8. Medical, Policy, History etc. 9. Veterinary Sciences 10. Pharmacy

* See Brockhaus-Efron, vol. xxxiv, 1902, p. 755

1863

Physical-Mathematical Faculty	Medical Faculty
1. Pure mathematics (3 teachers)	1. Anatomy
2. Analytical and Practical Mathematics	2. Pathology
3. Astronomy and Geology	3. Physiology
4. Physics (2 teachers)	4. General Pathology
5. Physical Geography	5. Embryology, Comparative Anatomy
6. Experimental and Theoretical Chemistry	6. General Therapeutics
7. Mineralogy	7. Pathology and Therapeutics
8. Geognosy and Palaeontology	8. Clinical Therapeutics
9. Botany (morphology and systematisation, anatomy and physiology)	9. Hospital Therapeutics
10. Zoology (comparative anatomy and systematization, anatomy and physiology)	10. Theoretical Surgery
11. Technical chemistry	11. Clinical Surgery
12. Agricultural chemistry	12. Hospital Surgery
	13. Midwifery
	14. Medical Policy, History etc.
	15. Medical Chemistry and Physics
	16. Pharmacology
	17. Theoretical and Practical Pharmacology

APPENDIX II

TWO LETTERS FROM CHARLES DARWIN TO V.O.KOVALEVSKY*

(1) May 21, 1873.

My Dear Sir,

I thank you for your extremely interesting letter. Your paper in the Proc. of the Royal Soc. appeared to me a very valuable contribution to science; and if I had known your address I should have written to you at the time. But what is far more important than my judgement, I observe that Prof. Flower, in his lectures, quotes and approves of several of your generalisations. I am extremely glad to hear that you have been successful in your further researches. The dedication of which you speak will be very gratifying to me, and I look at it as a great honour.

I am much obliged to you for telling me about your brother's work. I am not sure whether you mean to say that the larva of Angrope show some real affinity to Sagitta, or merely resembles it in external form.

In the former case it is a wonderfully fine discovery; for I remember even in the days of the Beagle, speculating on what relationship Sagitta could have to the other great groups of the animal kingdom. If I am right in my supposition, few men will have made such fine discoveries as your brother with respect to this case, and that of the Ascidians.

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* (1) From Izbrannye Pis'ma [redacted]. ,pp.232-7.

(2) From Collection at Burndy Library, Norwalk, Connecticut, with their kind permission.

The discovery of the bird with teeth and bi-concave vertebrae is indeed a grand one. Some of our palaeontologists think that Dinoceras was a true ungulate: and if so it ought to come under your review. Cope however maintains that it is a true pro-boscidian. I can plainly see that you and your brother, in your different ways have a grand career before you. As for myself my health has been of late somewhat better; and I am now entirely engaged on the fertility of plants.

With all good wishes believe me yours very sincerely,

C.D.

(2) Jan. 2nd, 1881*

My Dear Sir,

I thank you for the Photograph and your kind new year wishes, which I very heartily return. I hope that your [ ]+ affairs prosper, and I am well afraid that you deserve that they should prosper. - As for myself I am fairly well, but feel very old with failing strength.

My dear Sir
Yours sincerely,
Ch. Darwin.

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*Darwin wrote 1881 by mistake on the letter. The postmark on the envelope is 1882.

+I am unable to decipher this word.

APPENDIX III

AN EXTRACT FROM "WITH DARWIN AT DOWN"

BY K.A.TIMIRIAZEV* TRANSLATED BY S.WHITE.

After a few minutes Darwin came into the room quite suddenly. I have already taken the opportunity of describing my first impressions of him. The thing was that the portraits of him with his long grey beard, which are now well known, were not known at all at that time. Only one portrait, the one included in the German translation of the Origin of Species (and in my own book Charles Darwin and his Teaching) was known then. In this portrait, which had been made at the beginning of the 1850s, Darwin was shown forty years old, clean shaven and with closely cropped side whiskers. It was a half length portrait and for some reason the imagination filled it in with the figure of a shortish stout man in which one could make out a merchant or even a sportsman - whatever you liked but least of all a thinker of great depth and genius. But in front of me stood a majestic old man with a large grey beard and deeply sunken eyes whose peaceful caressing glance brought the human qualities to the forefront, making one forget the scientist. In a word a comparison with an ancient wise man or an old Testament patriarch involuntarily suggested itself, a comparison which I stated then and repeat today.

I cannot recall how the conversation started. I only remember that it was Darwin who began it and that not for a second was I forced to experience the uncomfortable position of a man having to explain or justify his blundering action - the intrusion into the house of a

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*Nauka i Demokratiia, pp. 98-107.
Timiriazev visited Darwin in 1877. "U Darvina v Downe" was first printed 1909.

great man, a tireless worker, who said of himself diem perdidi when he had not completed a planned work, a man who had retired to his far off corner so as to protect himself specifically from such importunate visitors, such as myself at that moment, who deprived him of both time and health. After a little time all that I was aware of was the infinitely good and affectionate old man in front of me with whom I was chatting as if I had known him all my life. He did not have the complacent peace of an old man who had 'accomplished everything in his life' and who looks down condescendingly and haughtily on the strange ways of youth, having removed himself from the bother of the world. There was nothing unctuous or preaching in what he was saying - on the contrary his whole speech retained a cheerful fighting character filled with humour and fine irony, and it touched upon questions of life and science that interested him a lot. Even at the beginning of the conversation there were none of the usual questions that one finds even among educated Europeans: "Isn't it true that in Russia it is very cold ... and aren't there a lot of bears?" Only when his wife asked: "What would you like - tea or coffee?", did Darwin hasten to answer for me: "Coffee of course. Surely one can't offer a Russian our tea", showing that he had heard of the common Russian superstition that there was no tea in Europe to compare with Russian tea, a superstition that could be explained in the good old days by the saying "tea does not love the sea", but for which there was no basis these days.

He made up for this, however, when the conversation turned to serious scientific topics. Here he immediately assumed a totally English character. Having learnt that

I was doing work in plant physiology he immediately took me aback with the question: "Of course, you must feel very strange in a country where there are no plant physiologists?" Only a true Englishman, proudly aware of his nation's worth, could speak so openly and mercilessly of its failings, knowing that this was the only means of getting rid of them. Naturally I couldn't help agreeing except with one reservation:"It is true that I have not come across any ... with one exception - the greatest of all time and all peoples". From that question and the ensuing conversation I guessed that I had arrived in Down at a very convenient moment, although I only knew this with certainty much later. It is well known that after the publication of the Origin of Species and other works which developed individual parts of the theory, Darwin concentrated exclusively on botany, experimental and physiological botany; the aim of all these works was to demonstrate the fruitfulness of his theory as a 'working hypothesis'. At the time of my visit he and Francis were engaged in research that would make up the contents of a whole volume The Power of Movement in Plants.

Of course, he was forced to face the fact that in this sphere English science, having given (without speaking of other branches) so many leading figures to both descriptive botany and animal physiology, had not brought to the forefront even one plant physiologist, and did not even have one laboratory furnished with all the equipment necessary for that kind of research. I was only certain of this fact, however, nearly 30 years later when I read his letter to Mr. Dyer, written a few months after my visit to Down, and which I can't help giving myself the pleasure of q uoting here: "I have a very strong opinion that it would be the greatest possible pity if the Phys(iological) Lab., now that it has been built, were not supplied with as many good instruments as your funds can possibly afford. It is quite possible that some of them may become antiquated before they are much or even at all used. But this does not seem to me any argument at all against getting them, for the Laboratory cannot be used until well provided; and the mere fact of the instruments being ready may suggest to some one to use them. You at Kew, as guardians and promoters of botanical science, will then have done all in your power, and if your Lab., is not used the disgrace will lie at the feet of the public. But until bitter experience proves the contrary I will never believe that we are so backward. I should think the German laboratories would be very good guides as to what to get; but Timiriazeff of Moscow, who travelled over Europe to see all Bot. Labs., and who seemed so good a fellow, would, I should think, give the best list of the most indispensable instruments."*

As if guessing the question bothering him at that moment I began to confidently reassure him using the theme "there are no people before there are people", a saying certainly appropriate for the country of that great scientist even if not always justifying itself in the homeland of the great satirist.+ It is unnecessary to

*More Letters, vol. II, pp. 416-7.

+Saltykov-Shchedrin.

say that our mutual expectations were not slow to fulfil themselves, and Jodrell Laboratory at Kew, a tiny little house that would fit into any large room of one of our own institutes, became the centre of a whole number of researches which have already become classics. The conversation then moved from plant physiology to my work. Having learnt that I specialised in the study of chlorophyll, Darwin without hesitation pronounced those words, quite striking from the lips of a man standing on the sidelines of physical and chemical questions, words which I have had occasion to quote many times: "Chlorophyll is perhaps the most interesting organic substance." It is interesting that his last notes which appeared a few days before his death were namely about chlorophyll. He then began to question about what in England, besides Kew, interested me, especially from a botanical point of view. I answered that I was going to Rothamstead the following day and indicated that the curious experiments taking place at that time on the change in structure of meadow flowers under the influence of artificial fertilizers were interesting from the point of view of the 'struggle for survival'. While I was speaking he made some signs to his son, and when I had finished said reproachfully: "You see, a man has come practically from the ends of the earth and tomorrow is visiting Rothamstead, and we are still making our plans." Again, many years later when the first collection of letters appeared, I found out that Darwin was planning a large number of experiments into artificial culture as a means for changing form and for that reason had entered into a correspondence with the well known Rothamstead chemist Gilbert. Around that time he had thought up with amazing insight experiments for the artificial development of plant growths (oak galls etc.) as well as for study of the laws of variation. For thirty years since that time the problem has not moved at all! I point this out as proof that Darwin's thought was continuously turning, especially in his latter years, to this new branch of science which even if it was not an essential part of "Darwinism" did represent, as I have pointed out more than once, its natural development.

From botany we turned to science in general. Darwin noted with special pleasure that there were keen supporters of his theory among the young Russian scientists. He referred to the name Kovalevsky, most of all, and when I asked him which of the brothers he had in mind, thinking it most likely to be Alexander the zoologist, he replied: "Excuse me, no, I think the palaeontological work of Vladimir to be of even more significance." I repeat these words as the unhappy Vladimir Onufrievich did not happen to be "a prophet in his native land". If I am not mistaken his compatriot examiners contrived to fail him in his master's degree precisely in that subject palaeontology, where he had already earned world wide fame. In the middle of this conversation Darwin suddenly perplexed me with the unexpected question: "Tell me why do German scientists quarrel so much between themselves?" "You are the best person to answer that one" I replied. "How me? I have never been to Germany." "Maybe, but this is only another demonstration of your theory: it must be that there are too many of them. It is another demonstration of the struggle for survival." Darwin hesitated for a moment and then burst into good-humoured laughter. Finally the conversation turned to the theme that I had been wanting to introduce a long time, namely what was he himself busy with at that moment. He proposed that we should stroll into the greenhouse where he was carrying out some new experiments on insectivorous plants. Despite the fact that there was a July heat (though the day was dull) and that the greenhouse was only a few steps away, both his wife and son fussed around and quickly produced that shawl and soft felt hat that are now well known from photographs. In front of the verandah there was quite a large lawn with the closely mowed English grass that is like velvet; despite this, or more accurately because of it, no one feared to walk, sit or lie down on it. The flower beds were nothing special. The greenhouse was at the opposite right hand corner of the garden; it was small, the size that any Russian merchant might have for growing his hydrangeas and pelargoniums in, but it was graceful and light thanks to a light iron framework and glass washed very clean as in Holland. Only later, again from the same letters, did I find out how long Darwin had hesitated before allowing himself this luxury, which was essentially a necessary tool for his work, and how pleased he had been when it was finally ready and he began to receive exclusively 'botanical' (as our gardeners say) plants from Kew and the best gardens of this country of famous gardeners, rather than the usual flowers. As is well known collecting plants was one of Darwin's first passions. The very earliest portrait of him as a child shows him with a bunch of flowers in his hands. We were met at the door of the greenhouse by the old gardener, the same one whose delightful anecdote about Darwin was recalled by Lubbock the other day: "He's a good old man, only look what a shame it is that he can't find himself anything worthwhile to do. Judge for yourself: he stands for several minutes staring at some flower of other. Now surely a gentleman who had a serious occupation wouldn't do a thing like that?"

At the time of my visit Darwin was engaged in answering the objection that he had not proved what use insectivorous plants received from animal food and that this process was not feeding at all, but bacterial decomposition. I saw a whole row of turfed sundew: each one was partitioned by tinplate into two halves; the leaves of one half were fed on meat, the leaves of the other left without meaty food, and it was clearly visible that the former plants were much stronger than the latter.

While displaying his charges Darwin, as if both justifying and defending himself, pointed out most peaceably that "he, it seems, is not mistaken" and that the results of the experiment supported him. Since then we have learned from his son's essay that of all the objections raised against his theory it was this one that had annoyed him most of all.

When we returned to the house, arriving in time for coffee, the conversation took a more general turn. It is well known that Darwin had to rest during the second half of the day. During this period his wife read aloud to him, usually novels with happy endings, not of a very high quality as Darwin himself confessed. However, occasionally an exception was made for something of a more serious nature. On my visit the well known book on Russia by Mackenzie Wallace lay near him on the table. It is necessary to point out that although it was already fifteen years since the emancipation of the serfs many Europeans were still unable to forget that peaceful revolution where 20 million were freed from serfdom as well as from the soil, especially as they were forced to compare it with the emancipation of the negroes in America, which had only come about after a bloody battle. In his voyages round the world Darwin had learnt to hate slavery with all his might and this gave him a reason (and surely he was not the only one) to see the future of the Russian people in an extremely rosy light. Another thing that interested him was the emerging freedom of thought in Russia. "A society in which such books as Buckle's 'History of Civilisation' are widely distributed (a fact most likely taken from Mackenzie Wallace) and where Lyell's books and his (Darwin's) 'Descent of Man' are freely read, cannot return to a traditional outlook on the basic questions of science and life", he said.

Two or more hours flew by without noticing and although I didn't detect any trace of tiredness in his voice Darwin rose to take his leave explaining that any conversation with whomever it may be, except his very closest, excited and tired him even affecting his sleep and so he was now not sure whether that day would go unpunished. "Of course you would like to have a portrait more like me than that one in your book?" he said approaching his wife's desk and taking out an apparently homemade photograph and thereupon signed it putting the date 25th July 1877. Having said goodbye once more he left the room to go and lie down and rest but soon to everyone's astonishment he returned saying: "I came back to tell you a couple of things. At this time you will meet many foolish people in this country who can only think of drawing England into war with Russia, but be quite sure that in this house sympathy is on your side and every morning we pick up the papers hoping to read news of your new victories."

It is only possible to evaluate these words in their historical perspective . . .

Darwin's words simply signified that he stood on the side of the 'great old man' [Gladstone] and not that of his triumphing opponents. It is comforting to remember that in a country where thought willingly takes a holiday everytime when, as the saying goes, 'it becomes difficult for a man', that in this country at a difficult time the sympathy of its greatest thinker as well as of its greatest statesman was on the side of the Russian people. It is twice as gratifying to remember about this at the present time when again there is hope for an entente cordiale between these two peoples, at a time when the Russian people are not screaming about the emancipation of other peoples - what business is that of theirs - but themselves are convulsively struggling to defend their right to simple human existence.*

The words quoted above were the last I heard from Charles Darwin. When he had left Mr. Francis proposed that we

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*Timiriazev is referring to the Balkan wars in the late 1870s and then to the period prior to the 1st World War.

should take a look at his study. Thanks to photography it is now also well known - this small room with the ordinary fireplace, the simplest of desks in the centre and a small couch used by the tireless worker when his inexorable illness overcame him. The practically total absence of what we are accustomed to associate with the concept of a library was shown by this study. It is known that Darwin's attitude to books was quite singular. If anyone should be able to truly despise him it would of course be the bibliophiles, or more accurately the bibliomaniacs, who value a book as a thing, not allowing themselves to cut some old publication in case of destroying its antique value, or providing valuable binding for some quite insignificant book. Darwin valued in a book only what was necessary in it for him and therefore often tore out vital pages so as to avoid cluttering up his table and room. The room on the top floor where Francis himself worked was even more humble. At the time of my visit it was being used as a laboratory to carry out experiments for Darwin's new and latest large work "Power of Movement in Plants" already begun at that time.

It was time to think of leaving. Having refused quite firmly the kind offer of a carriage I set off on the return journey. For part of the way Mr. Francis accompanied me. But soon we were surrounded by the shrieks and infectious laughter of a gay swarm of young boys and girls. Darwin introduced them to me. They were 'the Lubbocks' (and their guests?), apparently bringing, as one reads in Darwin's letters, a note of carefree joy into the serious life of the hermits of Down. Afterwards I often remembered that meeting on a remote English lane. This cheerful English youth bubbling with life, having fun in the countryside, less than anyone else needed reminding of 'The Joys of Life' and 'The Beauties of Nature'.

Not wishing to distract young Francis from the gay company I hastened to take my leave and quickened my step so as to catch my train. The return journey appeared to go much quicker because of the cooler weather.

As soon as I had returned to London, despite the late hour, I could not bear not to share my fresh impressions with D.N.Anuchin who was also staying in London at that time. Dmitri N..... poured a whole torrent of reproach down on me because I had, so it seemed, hidden my pilgrimage from him, deprived him of a unique occasion which of course would never repeat itself etc., etc. I remember that in justification I told him how I had gone sure of failure, that it was extremely natural that I didn't wish to have the door slammed in my face in front of a witness and that in any case it was not my fault that the great scientist had been on that occasion the friendliest of people.

APPENDIX IV.

A SHORT EXTRACT FROM "AN ESSAY ON THE QUESTION OF THE ORIGIN OF SPECIES"*

BY I.I. MECHNIKOV.

TRANSLATED BY S. WHITE.

A natural result of the fact of the existence and wide occurrence of struggle in nature is that there must be winners and losers. It is also easy to understand that the former must be individuals better adapted to the given conditions, i.e. individuals possessing some sort of favourable characteristics, characteristics either lacking completely or developed to a lesser degree in those individuals that lose the struggle. These propositions, logically derived from the principle of the struggle for survival, encompass the basic idea of the theory of natural selection. This basis stands so firmly that there can hardly be anyone who doubts in the present time the existence of natural selection, or the survival of the fittest as Herbert Spenser calls it. Therefore the most important questions are those of the significance of this process in the formation of organic forms, of its role in nature generally and of the way in which it works. Among the transformists there are many differing views concerning these principle points; at the same time as Darwin considers natural selection to be the most important if not the sole reason for the formation and variation of species, Nageli arrives at the final conclusion, that "in the plant kingdom there can be no talk about natural selection in the Darwinian sense" . . . —

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* O Darvinizme, pp. 135-45. 'Ocherk voprosa o proiskhozhdenii vidov'. First published 1876.

In view of the tremendous theoretical significance of natural selection it would be highly desirable if the detailed treatise promised by Darwin on this question could appear as quickly as possible. However essential and interesting the many works published by Darwin after the Origin of Species have been, all the same not one of them could develop his basic views as satisfactorally as would a detailed research of natural selection - the cardinal point of his whole theory. The compressed and at the same time laconic exposition is not interpreted by everyone in the same way, and consequently there often are misunderstandings over very important points (such misunderstandings are found most of all concerning the principle of divergence of characteristics) . . . .

However difficult it is in our present state of knowledge to answer the basic questions posed above in relation to natural selection, it is all the same necessary to attempt to answer them to the best of one's ability now. With this aim in mind let us turn to the works of Darwin himself. Having expounded (in ch. 4 of the Origin of Species) the a priori basic principles of natural selection, he stops on the proposition that this factor selects those characteristics which are extremely insignificant in the eyes of the systematist. He points to a number of facts to confirm this and, these are most valuable since, as I pointed out earlier, information about this factor is very bare. Most of all he points to the selection of colour or to the so-called protective colouring i.e., to the fact observed some time ago, that many animals are the same colour as their surroundings and when the colour of the latter varies the colour of the animals correspondingly alters; thus, for example, some northern and alpine forms are white in the winter and a different colour more suited to the colour of buds or dry leaves etc. in the summer. Darwin quite rightly links these phenomena with the action of natural selection, since the protective colouring, protecting the animal from being seen by enemies, gives it an advantage in the struggle for survival . . . One can even say generally that examples of protective colouring are an important factual proof of the existence of natural selection. But at the same time they throw light on another side of the question as well. It is well known (see ch. 7) that colour is a characteristic distinguished by its comparatively firm ~~hereditary~~ inheritance, and therefore is often not wiped out when crossed. Darwin collected a number of examples where parents of different colours gave birth to offspring who inherited the colour of one of the parents and never represented an in-between colour. Although Darwin does not consider that this type of inheritance is a general law, all the same, with the help of the facts used by Darwin himself, one can come to the conclusion that in the fixing of the protective colouring, natural selection must have received considerable help from the fact of the firm inheritance of colours.

We are convinced that this protective colouring must have appeared suddenly and then been fixed by natural selection, . . .

Let us turn to other factual conclusions drawn by Darwin in favour of the existence and wide distribution of natural selection. He has collected a whole number of examples where colour appears to have had not a direct (as in the examples of protective colouring) but an indirect influence on the direction of natural selection.

. . .

In all these examples colour does not play any direct role; it is only indirectly related to those characteristics which ensure victory in the struggle. But what about these characteristics themselves? Not once does Darwin list them, and so it appears that they must be hidden very deep inside the organism, inside the matter that makes up the constitutional individuality of the organism and which is primarily connected with its chemical and molecular composition. In any case there is no doubt that they are not in any way clearly morphological characteristics distinguishing the race or species, because otherwise they could never have escaped the notice of observers.

In some cases Darwin himself points to the fact that natural selection acts "without any apparent reason" and, generally, all the examples of natural selection put forward by him in both works relate to characteristics either very unimportant or completely insignificant from the point of view of morphology and systematics. All this serves as further confirmation of the general conclusion made in the previous chapter, namely the proposition that the characteristics most essential in the struggle for survival and therefore fixed by natural selection do not necessarily correspond to the characteristics of most morphological significance.

If we don't count the treatise on The Descent of Man, there are no attempts by Darwin to prove, by direct observation of the facts, the applicability and effectiveness of natural selection in the case of any particular systematic group. Wallace did make such an attempt in his chapter 'Malayan Papilionidae as an illustration of natural selection'. In this chapter, which displays all the talent of its author, we are told many extremely interesting and important facts concerning the variability of the day butterflies in various parts of the Malay archipeligo. . . however . . . this attempt to give an example of the action of natural selection was not entirely satisfactory, as Wallace himself realised, as we can see from the following words: "However it may have happened, the fauna of Tselebes is undoubtedly most distinctive in all its aspects; although we are not able to show satisfactorally how this result was achieved, all the same I think that it is hardly possible to believe that the amazing variation in the wings of so many butterflies of that island is a result of the complex interaction of all living beings in their struggle"* . . . Further on the lack of a firm basis for natural selection is brought out even more clearly . . . From this it is clear that the Malayan Papilionidae which on the one hand provide favourable examples of natural selection (especially with respect to the cases of striking forms and colours), on the other hand demonstrate the fact that the role of this factor is insufficient to explain all or even the majority of

*This and other quotations are translations of the Russian and not the original English.

of regular variations. Thus a closer acquaintance with the facts produced in favour of natural selection by both the founders of that theory show three things. Firstly, in the cases where the influence of natural selection is more or less clear and undisputed, firm heredity was also present to help (in the case of protective colours). Secondly, natural selection often acts upon characteristics which are more hidden than those that make up the morphological distinctions of races and species. Thirdly, these very morphological distinctions cannot always be attributed to the action of natural selection.

In the preceding pages I have tried to show that the main factors which are put forward as proof of the existence of natural selection also point to the insufficiency of this process as alone being able to explain the total systematic affinity of organisms. Keeping this basic point of view in mind, I shall now turn to an analysis of Darwin's theoretical propositions concerning the basic laws of natural selection.

"Natural selection, - wrote Darwin (98) - must be in a position to influence and change organisms of all ages, accumulating variations that are useful for every period of life, and which (according to the laws of heredity) must be inherited at the corresponding age". Thus we see, for example, that the taxonomic colouring which is subject to the indubitable influence of natural selection, is a characteristic not only of the grown animal but also of the larva (for example with many butterflies) and even of eggs (with many birds).

Relating this situation to the basic dogma of Darwinism, according to which selection is the result of over-population ("multiplication in geometrical progression"), one would have to suppose that selection acts strongest of all on eggs, then on larvae and finally on grown organisms. . . . It is also well known that as a general rule mortality is greater in the larval stage than in the grown-up stage (not counting here of course mortality from old age, since it has nothing to do with the problem) . . . Struggle in an active form or even real competition,i.e. struggle for a piece of bread, is not applicable to the childhood stage, which is most prone to mortality.

But from the point of view of Darwinism the most important is the struggle for life i.e. in the given circumstances competition over the transference of disadvantages related to the cutting of teeth, development of the skull, immunity to disease etc. This less noticeable and purely passive struggle possesses, however, more strength than the active one. Chances of mortality in a struggle over the cutting of teeth are much greater than in war where the most deadly weapons are used.

A comparison of all these facts with the basic tenet of Darwinism, that if not all then at least the large majority of species resulted from the action of natural selection, can bring one to the conclusion that specific characteristics should be most sharply defined in eggs, then in larvae and only then in grown individuals. The facts show the exact opposite. Although there is no doubt that the eggs of many animals possess very sharp specific differences, this cannot be made into a general rule, and, most important, it cannot be applied to larvae. Recently a lot of attention has been paid, especially by the followers of Darwin, to the fact that many animals, very dissimilar in their grown stage, are extremely like each other in the larval stage. This fact is especially striking in the class of crustacea, whose most varied members in their larval form are more similar to each other than two neighbouring families or even species in the grown animals. To avoid misunderstanding it is necessary to note that these larvae lead completely independent lives and therefore in all respects are exposed to an open struggle for survival, which has equipped some of them with protective adaptations from their enemies etc. It is also essential to point out that the multiplicity of larvae is a condition in itself favourable according to Darwin, for natural selection, since the more individuals the more individual variations, and consequently the more material available for selection.

These ideas bring one to the conclusion that the important facts of the real life of organic nature do not tie up with the basic propositions of the theory of selection.