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ON THE JAPANESE SPECIES OF VICARYA

BY

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With 1 Plate

The genus *Vicarya* was established by D'ARCHIAC and M. J. HAIME in 1854,¹⁾ based on *Nerinea? verneuili* D'ARCHIAC (Pl. XXI(I), Figs. 14, 15, 20), a species originally described in 1850,²⁾ from the topmost bed of the Gaj series in Sind, Western India. Based upon *Nerinea? verneuili*, the genus was defined in the following way:

Coquille turriculée ou conoïde, composée de 12 à 14 tours aplates, séparés par une suture simple, linéaire, à peine visible. Les premiers sont ornés, à la partie supérieure, d'une rangée de granulations serées, margaritifformes qui, dans les suivants, sont plus espacées, plus grosses et se changent en tubercules coniques ou pyramidaux de plus en plus saillants et au nombre de 8 seulement sur le dernier. Une seconde rangée de granulations plus petites, règne sous la précédente sur les 6 ou 7 premiers tours, et se continue jusqu' au dernier sans qu'elles augmentent de volume. Une troisième rangée, contigue à celle-ci, mais un peu plus prononcée, borde en dessus une bandelette décurrents, concave, limitée en dessous par une cordelette une, simple, étroite, qui accompagne la suture. Cette bandelette montre nettement des stries d'accroissement concaves d'arrière en avant qui se continuent en dessus dans l'espace occupé par les tubercles, et s'arrêtent en dessous à la cordelette suturale. Base du dernier tour un peu convexe, présentent au dessous de la bandelette trois ou quatre cordelettes granuleuses, coupées par les stries d'accroissement obliques, arquées et inégales. Ouverture petite, arrondie, subcanaliculée au sommet et à la base. Bord droit, mince, argué en avant, munivers sa partie moyenne d'un sinus profond, à bords parallèles, et au-dessus duquel il remonte pour joindre l'avant dernier tour par une courbe semblable à la première. Bord gauche revêtu d'une épaisse et large callosité qui s'étend sur une grande partie de la base, réunissant l'extrémité de la columelle à deux gros tubercules mousses, dont l'un est situé avec celle-ci dans le plan de l'axe, et l'autre contre la bandelette de l'avant-dernier tour. Hauteur, 82 millim.; diamètre du dernier tour, 33.

Localité. Calcaire grisâtre avec des grains de fer oxydé hydraté de la chaîne d'Hala.

Since the establishment of the genus by D'ARCHIAC and HAIME, the systematic position of *Vicarya* has been a subject of considerable debate, being placed in subgeneric rank of the genus *Cerithium* by K. A. v. ZITTEL in 1881,³⁾ and by W. D. SMITH in 1910,⁴⁾ and in subgeneric rank of *Potamides* by P. FISCHER⁵⁾ and G. W. TRYON⁶⁾ in 1887, and also by K. MARTIN in 1879.⁷⁾ W. H. DALL⁸⁾ includes *Vicarya* into the Cerithiidae as a subgenus of *Cerithium*, following the procedure of K. A. v. ZITTEL and W. D. SMITH. However, in general usage, *Vicarya* is now regarded as a valid genus in the subfamily Potamidinae.

Subsequent to the publication of the genus *Vicarya*, many species have been described and referred to it, and the ones with definite specific names, are the following, namely:

- 1) *Vicarya verneuili* (D'ARCHIAC)⁹⁾Gaj series, India
- 2) *V. fusiformis* HISLOP¹⁰⁾near Rajamandri, India
- 3) *V. callosa* JENKINS¹¹⁾Mount Séla, Java
- 4) *V. daphne* WHITE¹²⁾Pernambuco, Brazil

- 5) *V. sappho* WHITE¹³⁾ Pernambuco, Brazil
- 6) *V. callosa* var. *semperi* MARTIN¹⁴⁾ Philippine Islands
- 7) *V. strombiformis* (SCHLOTH.)¹⁵⁾ Isle of Wight
- 8) *V. eocenica* COX¹⁶⁾ Eocene of India
- 9) *V. branneri* HILL¹⁷⁾ Glen Rose beds, Texas
- 10) *V. baculum* YOKOYAMA¹⁸⁾ Mino, Japan
- 11) *V. verneuili yokoyamai* TAKEYAMA¹⁹⁾ Mimasaka, Japan

Vicarya fusiformis described by S. HISLOP²⁰⁾ from Katéru in the north of Rajamandri, as already noticed by H. M. JENKINS,²¹⁾ is quite different from the genus *Vicarya* and belongs to an entirely different genus. The figures of *V. fusiformis* in S. HISLOP's work readily prove the above statement and further remarks are unnecessary. *V. daphne* and *V. sappho*, described by C. A. WHITE²²⁾ from the Cretaceous rocks of Brazil and referred to *Vicarya* with question, reveal characters which diverge from *Vicarya*; these also must be rejected. *Glauconia* (*Vicarya*) *branneri* reported by R. T. HILL²³⁾ from the Glen Rose formation of Texas, is not a member of *Vicarya* and belongs to an entirely different gen. *V. strombiformis* reported by O. WHITE²⁴⁾ from the Wealden rocks of the Isle of Wight, also belongs to some genus other than *Vicarya*.

Rejecting the above species which have hitherto been assigned to *Vicarya*, the following are left to be dealt with, namely:

<i>Vicarya verneuili</i> (D'ARCHIAC)	<i>Vicarya callosa</i> JENKINS
<i>V. eocenica</i> COX	<i>V. callosa</i> var. <i>semperi</i> MARTIN
<i>V. baculum</i> YOKOYAMA	<i>V. verneuili yokoyamai</i> TAKEYAMA

There remains almost no doubt that *Vicarya eocenica* (Pl. XXI (I), Figs. 1, 7, 8) described by L. R. COX²⁵⁾ from the Lower Ghazij shale (Middle Laki) of Harnai, Baluchistan, India, is a valid species. This species was originally described in the following way:

Much smaller than the genotype (*V. verneuili* D'ARCHIAC and HAIME),²⁶⁾ but of similar proportions. Whorls flat, separated by linear but well-incised sutures; ornamented with three rows of granules, separated, on the later whorls, by a few fine obscurely granulated threads; a narrow ungranulated ridge occurs near the anterior suture; on the later whorls the most posterior row of granules become more conspicuous than the other two. Base short, ornamented with concentric threads, and separated from the side of the last whorl by a well-defined ridge, which lies slightly below the prolongation of the last suture. Outer lip much thickened, with a deep sinus lying between the second and third rows of granules (counting from the posterior suture). Aperture not known intact.

L. R. COX has recognized that the ornamentation of his specimens are nearly identical with the early whorl of *V. verneuili*, but in that species sharp spine-like tubercles are developed in the later whorls, also that *V. eocenica* never attains such a large size as the genotype species. The features by which L. R. COX distinguishes his *eocenica* from the genotype species seem to be good characters, and we agree with T. TAKEYAMA²⁷⁾ in recognizing the Eocene form as a valid species. By the refined methods of previous authors, we find that *Vicarya eocenica* COX, is the oldest known member of the genus.

According to K. MARTIN, *Vicarya callosa* JENKINS var. *semperi*,²⁸⁾ which he described from the Philippine Islands as a varietal form of *V. callosa* (Pl. XXI (I), Figs. 5, 6), is nothing but a local variation²⁹⁾ of *V. verneuili*, the species into which he also includes *V. callosa* as mere variation. This procedure is not followed by T. TAKEYAMA,³⁰⁾ who recognizes the following four members of *Vicarya*, namely, *V. verneuili*, *V. callosa*, *V. eocenica* and his *V. verneuili yokoyamai*.

However, the question arises as to, are we to follow MARTIN and regard *V. verneuili*, *V. callosa* and *V. callosa* var. *semperi* as belonging to a single species of highly variable characters or are we to follow TAKEYAMA and take *semperi* as a synonym of *V. callosa* but regard *V. callosa* and *V. verneuili* as distinct or valid species.

There is no doubt as to the validity of the genotype species and evidently, the Eocene species is also valid. Therefore, our attention may be directed to the following species which have been assigned to *Vicarya*, namely, *V. callosa* JENKINS, *V. verneuili yokoyamai* TAKEYAMA, and *V. baculum* YOKOYAMA.

Vicarya callosa (Pl. XXI (I), Fig. 4) was first described by H. M. JENKINS³¹⁾ from a greenish-grey sandy marl of Mount Séla in the Kuningan District of the Tjeribon Residence in Java. The original description is as follows:

Shell thick, turreted, elongately conical. Whorls almost cylindrical, but somewhat wider at the base than at the upper portion; with a raised nodiferous band just below the suture, becoming gradually obsolete in the upper whorls; and also ornamented by one or two parallel ridges, closely accompanied above by a minor groove, between their lower margin and the nodiferous band. Suture linear, indistinct, occasionally manifested by the base of the upper whorl being produced so as to form a ridge. Aperture small, obliquely oval; inner lip distinct, furnished with a very large and very thick callosity, which extends forwards as a semicircle, and upwards, in the shape of a tongue, so far as the row of tubercles of the whorl above. Columella thickened at a distance of about one-third from the base. Outer lip and canal broken away.

The nodiferous band carries about ten inequidistant, unequal, obtuse, compressed tubercles, or short spines; and also a distinct groove running along the centre and over the apices of the tubercles. The last whorl is flat at the base and rounded-off towards the sides.

The figures given by H. M. JENKINS when compared with the subsequent figures (Pl. XXI (I), Figs. 2, 3) given by M. COSSMANN,³²⁾ show considerable difference in the strength of the spiral sculpture, but such differences are explained by the differences in the state of preservation, and since the described features of the original *callosa* are displayed on the subsequent figures, the two are certainly of the same species.

The difference between *V. verneuili* and *V. callosa* lies chiefly in the spiral sculpture, strength of the spine-like tubercles and in the degree of callosity of the aperture. These differences appear to be worthy of specific separation, for which reason we recognize both as valid, and not as a single species with remarkable variability, as expressed by K. MARTIN.

In regard to var. *semperi* MARTIN (Pl. XXI (I), Fig. 9), we are now in the following opinion. The original English description and remarks of the variety was given by K. MARTIN in the following way.

The turreted shell consists of flattened whorls, which are separated from one another by a distinct but not incised suture, and carry a number of sharply defined spiral beadings. Even on the older part of the shell five such beadings are visible, the last of which runs immediately in front of the after suture of the whorl, and is much stronger than the two beadings which lie immediately in front of it. Then follows a strong ridge, again succeeded by a very slender one on the anterior edge. On the younger parts of the shell sharp knots are situated on the last spiral of the whorls. They number eight to nine, and with the growth of the shell become modified into short, sharp prongs which stand at right angles to the axis of the shell. In front of this row of prongs, which accompanies the suture, one three spiral beadings are observable, of which the first two are the strongest, while the fifth spiral beadings of the older turns is covered by the succeeding whorl. The incremental lines are smoothly but deeply bent into the shape of an S, in such a way that the deepest incurvation, corresponding to the incision of the exterior lip, lies between the two strong spiral beadings on the frontal termination of the whorls.

The terminal whorl carries in front of the suture several more spiral beadings of variable strength. The canal is short and bent backward, the pillar is provided with a distinct fold, the interior lips being swollen and thickened in such a way that the thickening on the left forms a half-moon-shaped swelling which rests on the terminal whorl and is prolonged as a tongue to the right. The exterior lip is not preserved, but, judging from the incremental lines, it has the same shape as in *V. verneuili* D'ARCH. The length of the largest complete individual is 74 mm, and this size, to judge from the material at hand, is rarely or never exceeded.

A slight variation from the foregoing usual development is brought about by the interpolation of a fine additional beading between the two spirals which include between them the incision of the outer lip. In other cases these spirals are inconspicuous at this point, while between the horns two longitudinal beadings are developed.

V. callosa JENK. from Java is never provided with such prominent beadings as in the fossil here described, and only in very isolated cases is the sculpture of the latter feebly indicated on the former, so that the spiral sculpture of the Philippine fossil affords a good distinction. The Javanese form is also larger and stouter, and its prongs have a different character, while the callosity of the inner lip reaches farther back and here, as a rule, envelops a prong of the previous whorl. Nevertheless, the relationship of the fossil under discussion to the Japanese *V. callosa* JENK. is so close that I can regard it only as a local variety of the latter.

Among the specimens which total fourteen, studied by K. MARTIN, his figure 1 comes from Minanga, from the right bank of Catalangan, and figure 2 comes from the brook Dicamui in Luzon.

Advanced studies on *Vicarya* led K. MARTIN to express the opinion that *V. verneuili*, *V. callosa* and his var. *semperi* belong to one and the same species with highly variable characters. T. TAKEYAMA agreed with K. MARTIN in placing the var. *semperi* in the synonymy of *V. callosa*, but disagreed in respect to the relationship between *V. verneuili* and *V. callosa*.

The variability of *Vicarya* may be fairly great as stated by K. MARTIN, but when considered from the area of geographical distribution, the mere idea of variation in a local meaning should be given more attention than hitherto received. Firstly, the degree of variation noticed in specimens from a single locality is not great, but when the variation is studied on specimens from many geographically isolated localities, the degree is apparently considerable; as a result, is it a good procedure to agree that specimens from geographically isolated localities compared with each other and the whole taken as mere variation, true variation? If this is actually the case, then the term "variation" is evidently used without any sincerity, and only employed to accumulate easy procedure in study. Secondly, it is known that variation as employed by many authors, really represents an interesting case of divergency of character or evolution resulting from local adaptation produced by migration (difference in latitude, salinity, water temperature, etc.); in such cases, we are dealing with a problem which should not be passed by the mere term "variation", as this is really horizontal evolution. Thirdly, until specimens from a single locality and single horizon are proven to show the same degree of variation as shown by specimens from many geographically isolated localities, the lumping-method should be given strict consideration. Fourthly, it appears the mutation does not always show the same degree of differences that we find in variation even though both require time and changing physical conditions for their achievement.

Strictly speaking, figure 1 of var. *semperi* K. MARTIN is very close to the Japanese *V. callosa japonica*, especially in the shape of the tubercles and their relation to the axis of the shell-length, and in this feature it diverges from the original *V. callosa*, thus it may be a form intermediate between the Japanese and Javanese *Vicarya*. If, the present statement is accepted

by all, then we probably have before us a case of migrational-evolution or divergence of character produced or at least influenced by migration and succeeded by adaptation.

The only comprehensive work concerning the genus *Vicarya* in Japan is that by T. TAKEYAMA,³⁴⁾ since the detailed study made by I. SAGA³⁵⁾ was left in manuscript form. The large collection of specimens of *Vicarya* from various places in Japan, and stored in our Institute, now affords us the opportunity of expressing our views concerning the genus and its species in the Neogene deposits of Japan.

Recently, T. TAKEYAMA,³⁶⁾ as a result of his observations on the genus *Vicarya* in the Japanese Neogene, distinguished two forms, namely, *Vicarya callosa* JENKINS and his *V. verneuili yokoyamai*, and finds that the former is characteristic of the lower Miocene while the latter represents the upper. If this view is correct, then the value of *Vicarya* in the Japanese Neogene is of stratigraphical importance on the one hand and an important datum for studies on the geological history of the Neogene on the other. However, first attention must be directed to the validity of the Japanese *V. callosa* and to the value of *V. verneuili yokoyamai*.

In describing *V. verneuili yokoyamai* as a new subspecies, T. TAKEYAMA includes as its synonyms, *Cerithium* sp., an indetermined specimen which was reported by M. YOKOYAMA³⁷⁾ (1925), from Yumoto in the Zyô-ban region, and *Vicarya baculum*, specimens recorded by M. YOKOYAMA³⁸⁾ (1926), from Matubora in Mino, and not *Cerithium baculum*, a species originally described by M. YOKOYAMA³⁹⁾ (1923), from Nigisi in Kii and subsequently reported from Yumoto and Kadôno in the Zyô-ban region (1925).⁴⁰⁾

Cerithium baculum, a species which was first described from Nigisi in Kii province, was defined by M. YOKOYAMA (1923, p. 52), in the following manner:

Shell small, turrete, many whorled. Whorls hardly convex, spirally sculptured. The sculpture consists of a subsutural row of spinous tubercles and somewhat unequal beaded cords, three on the penultimate whorl and usually one less on the preceding one; while on the body-whorl there are many, being present down to the caudal end. The number of spinous tubercles is about ten on the last whorl. Periphery rounded. Base suddenly narrowed and furnished with about eight cords. Outer lip broken. Canal short, bent. Apical angle a little over 20°.

Judging from the description and figure of *Cerithium baculum* from Kii, the whorls are shouldered by a subsutural band and inclined as they grow; *Batillaria tateiwai* MAKIYAMA,⁴¹⁾ from the Meisen Miocene of North Tyôsen (Korea) is apparently related to *Cerithium baculum*, although not conspecific. In this connection it should be stated that T. TAKEYAMA⁴²⁾ refers *Cerithium baculum* from Kii to the genus *Clava*, while N. IKEBE⁴³⁾ states that T. TAKEYAMA has established a manuscript genus, *Vicaryella* to include such forms as *Cerithium baculum* from Kii and *Cerithium ishianum* YOKOYAMA⁴⁴⁾ from the Miocene deposits of Mino. However, Y. OTUKA⁴⁵⁾ has referred *Cerithium ishianum* to the genus *Proclava* with question marks. Since we have excellent specimens to discuss the manuscript genus name of T. TAKEYAMA, our views will be given at the end of this article.

Subsequently, M. YOKOYAMA recorded the second occurrence of his *Cerithium baculum* from Yumoto and Kadono in the Zyô-ban region. The description of the Zyô-ban specimens was given as follows: (YOKOYAMA, 1925, p. 12).

The shell is high-turrete, acute at apex and is composed of about seventeen whorls which are nearly flat, except the last one which is rounded towards the periphery. The ornamentation consists of a subsutural row of spine-like tubercles, some seventeen or eighteen in number of the body whorl, and several (usually six) unequal spiral cords of which the lowest or supra-

sutural one is the largest. Below the rounded periphery there are ten spiral cords more or less equal in size. Some of the cords on the whorls show a granular or bead-like aspect. It is about 49 millim. in height and 15 millim. in diameter.

Difference between the Kii and Zyô-ban specimens, as can be judged from the descriptive remarks and the annexed figures, lies chiefly in the number of spiral cords and in the strength of the beads of the subsutural band. Therefore, whether they are conspecific and have a range of variation, or whether they represent two different species, is hard to decide, mainly because the original specimens have not been studied. However, they may belong to the genus *Proclava* if not to the manuscript name of T. TAKEYAMA.

However, the *Cerithium* sp., which was described and figured by M. YOKOYAMA (1925, p. 12), from the Zyô-ban region resembles both the Kii and Zyô-ban *Cerithium baculum* but is distinguished from them by the possession of a fewer number of spiral cords, a broader shell, fewer tubercles and by the apical angle. This indetermined specimen referred to *Cerithium* by M. YOKOYAMA, was listed as a synonym of *Vicarya verneuili yokoyamai* by TAKEYAMA (1933, p. 134).

Sometime later, M. YOKOYAMA (1926, p. 219), figured three specimens from the Neogene deposits of Mino, two with the external shell preserved and one as a cast. These specimens were placed in the genus *Vicarya* by him, who then listed as its synonyms, his *Cerithium baculum* from Kii and his *Cerithium* sp., from the Zyô-ban region. In this procedure, he compared his specimens (especially the Mino ones), with *Vicarya callosa* JENKINS⁴⁶⁾ from the Miocene of Java (by literature?). His description of the Mino *Vicarya baculum* is as follows (YOKOYAMA, 1926, p. 219):

Our shell is large and turrete, the apical angle being about 24° or more. The number of whorls can not be exactly given, as the specimens are invariably lack the apical portion, but it seems to be over fifteen. They are as a whole, flattish, with a spiral band beneath the upper suture bearing spiny tubercles which number eight or nine on the body-whorl, about nine on the penultimate, eleven on the one preceding and about twenty on the third from the last; so that on the upper whorls they look like a close row of smaller beads. In the Javan fossil, the number of tubercles remains tolerably constant on all the whorls, the number being about nine. Another distinction lies in the number of spiral ridges below the tubercular band. There are usually three of these in our fossil with an intermediate thread between them and also between the upper ridge and the tubercular band; while in *Vicarya callosa* there are only two ridges. Moreover, the ridges in our fossil are finely tuberculated, while in the Javan they are smooth.

The *Cerithium baculum* and the *Cerithium* sp., previously described by M. YOKOYAMA may be immature forms of the Mino *Vicarya baculum*, in the view that he has considered them as synonymous. However, *Cerithium baculum* from Kii appears to be a species different from the Zyô-ban and the Mino specimens. TAKEYAMA (1933) has already proposed the name *yokoyamai* for the Zyô-ban specimens of *Cerithium* sp., and the Mino *Vicarya baculum*, as he considered them to be conspecific with his specimens.

However, if the Zyô-ban *Cerithium* sp., reported by YOKOYAMA is an immature form of the adult Mino *Vicarya baculum*, then we may expect the young whorls of the adult Mino *V. baculum* to correspond to the *Cerithium* sp., from the Zyô-ban region. However, it appears that the Zyô-ban *Cerithium* sp., is closer to *Cerithium baculum* from the Zyô-ban region rather than to the Mino *Vicarya baculum*. Here it should be stated that the Mino *Vicarya baculum* has been previously figured as *Vicarya verneuili* (D'ARCHIAC) by J. MAKIYAMA.⁴⁷⁾

The foregoing paragraphs are summarized in the following lines:

- 1) *Cerithium baculum* from Nigisi in Kii is superficially related to, yet apparently distinct from the ones described and figured under the same name from the subsequent localities above mentioned, providing the figures are correct.
- 2) *Cerithium* sp., from Yumoto and Kadôno in the Zyô-ban region is not strictly referable to the genus *Vicarya*. It may be related to the Tyôsen *Batillaria tateiwai* MAKIYAMA.
- 3) *Vicarya baculum* from Mino seems to be a true species of *Vicarya*, and distinct from the previously mentioned species, although identified with them by both YOKOYAMA and TAKEYAMA.
- 4) *Vicarya baculum* from Mino described and figured by M. YOKOYAMA is hardly distinguishable from and most probably identical with J. MAKIYAMA's *Vicarya verneuili* (D'ARCHIAC) on the one hand and TAKEYAMA's *Vicarya callosa* JENKINS on the other, yet it belongs to what TAKEYAMA described as *yokoyamai*.
- 5) If TAKEYAMA's *Vicarya verneuili yokoyamai*³⁸⁾ really includes as its synonyms the Zyô-ban *Cerithium* sp., and the Mino *Vicarya baculum*, both of YOKOYAMA, then its degree of variation is remarkable. So remarkable that even *Vicarya callosa* described and figured by TAKEYAMA would easily fall within the limits of its variation, resulting in a degree of variation much greater than that stated by K. MARTIN for the variety *semperi* from the Philippine Islands and *V. callosa* and *V. verneuili*.

From the foregoing summary as well as earlier paragraphs it can be noticed that our knowledge on the Japanese species of *Vicarya* is still in a state of confusion,⁴⁰⁾ and in the following pages we wish to make a survey of the genus and its species in the Japanese Neogene deposits.

The abundant specimens of *Vicarya* from various places in Japan, and now at our disposal, has revealed the presences of the following species and subspecies which are to be discussed upon, namely:

Vicarya callosa japonica SAGA (MS), subsp. nov.

V. callosa yokoyamai TAKEYAMA

V. callosa martini SAGA (MS), subsp. nov.

V. yatuoensis sp. nov.

Of the above mentioned forms of *Vicarya* from Japan, *V. callosa japonica* is distinguished from the species by the shape of the tubercles which are flat above and sloping below, while from *V. verneuili*, the present subspecies is distinguished by having no auxiliary rows of delicate beads or knots. *V. callosa yokoyamai* was distinguished from *V. verneuili* to which it was originally placed as its subspecies, by "the lowest spiral cord is beaded, that the narrow band between the upper two spiral striae is elevated, and that the callous deposit is smaller" according to TAKEYAMA. *V. callosa martini* differs from the species as well as from *V. callosa japonica* and *V. callosa yokoyamai* by the last two whorls or three only bearing tubercles while the rest consist of merely small beads. *V. yatuoensis* differs from *V. callosa japonica* in the sculpture of the whorls, less extensive tubercles and by the last whorl being shouldered instead of flat. *V. callosa martini* differs from the present one in the shape of the whorls, the sculpture and in the sinus. *V. callosa yokoyamai* also differs from the present one in the shape and sculpture of the last whorl.

The Japanese members of *Vicarya* are described in the following pages and figures are given of all the known species for the sake of comparison, in the annexed plate.

Key to the Species of *Vicarya*

- Shell moderately large, turreted, with many whorls. Adult whorls sculptured with subsutural band bearing granules or spines and spiral cords. Aperture with posterior groove and short anterior canal. Columella with median fold. Outer lip with sinus, inner lip with callous deposit. Aperture obliquely developed. Brackish-water in habitat *Vicarya*
- Shell not large, turreted, sculptured throughout with granules only *eocenica*
- Shell large, sculptured with weak spiral cords and subsutural band which has the spines sloping both above and below *callosa*
- Shell moderate, sculptured with granulated threads and subsutural band which has moderately strong spines *verneuili*
- Shell moderate, sculptured throughout with tuberculous spines, which are flat above and sloping below; whorls flat *callosa japonica*
- Shell large, sculptured on lower whorls with moderate spines, and two or three spiral cords, younger whorls with granulated sculpture; spines about 8 or 9 *callosa yokoyamai*
- Shell narrowly elongate, provided with spines on lowest whorls only, elsewhere with granulated sculpture, with three to four spiral cords which are generally granulated *callosa martini*
- Shell short conic, subsutural band with blunt protuberances, last whorl shouldered and expanded, spiral cords elevated and granular *yatuensis*
- Shell intermediate between *callosa* and *callosa japonica* *callosa semperi*

Vicarya callosa japonica SAGA (MS), subsp. nov.

Pl. XXI (I), Figs. 12, 13, 21, 22, 28, 31.

1917. *Vicarya callosa* var. *japonica* SAGA, Report on the Geology of the Tertiary Formation of Eastern Mino. Graduation Thesis, Inst. Geol. Pal., Tôhoku Imp. Univ., p. 17, fig. 1 (Manuscript).
1926. *Vicarya baculum* YOKOYAMA, Molluscan Fossils from the Tertiary of Mino. Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 1, Pt. 7, p. 219, pl. 28, figs. 4-6.
1932. *Vicarya verneuili* MAKIYAMA, Neogene Period, Iwanami Series in Geol. and Pal., pl. 1, fig. 5.
1933. *Vicarya callosa* TAKEYAMA, Notes on the Genus *Vicarya*, with Description of Two Japanese Forms. Jap. Jour. Geol. Geogr., Vol. 10, pp. 137-140, pl. 13, figs. 1 a-c, 2 a-b, 3.

Mr. I. SAGA in his detail study of the Japanese species of *Vicarya*, recognized that his *Vicarya callosa japonica* is distinguishable from *Vicarya verneuili* (D'ARÇHIAC) mainly in the absence of the auxiliary rows of delicate beads or knots. From *V. callosa* JENKINS, the subspecies differs chiefly in the shape of the spines, as can be seen from the original figures of H. M. JENKINS,⁵⁰⁾ and from the excellent illustration subsequently given by M. COSSMANN.⁵¹⁾

Since the manuscript name was not published, subsequent authors have applied such names as *baculum*, *verneuili* and *callosa* to what I. SAGA called *japonica*. Thus, it is noticed that no definite name has yet been found for the Japanese species of *Vicarya* which closely resembles *callosa* of JENKINS from Java. Abundant specimens of *Vicarya* now permits the writers to describe the hitherto called *callosa* from Japan, as a new subspecies, the description follows.

Shell large in size, heavy, turreted, elongately conical, with many whorls, of which the lower 13 are preserved. Whorls flat, nearly straightly inclined when tubercles are neglected, regularly increasing in size, each truncate conic, and separated from one another by a narrow yet distinct suture. Sculpture consisting of spirally arranged parallel ridges of which the uppermost on young whorls consists of granulations which soon develop into triangularly rounded protuberances, then into still larger or more tubercular protuberances, and about from the fourth from the largest whorl, they appear as narrowly produced triangular spines with rounded tips which number 9-11 on the body whorl; all spines flat on top, extending horizontally from longitudinal axis of shell and gradually sloping below, their bases about nearly equal to the interspaces between each spine or tubercles. Other two spiral ridges nearly equidistantly spaced, raised, and extending to apertural callosity. Growth lines fine, sigmoidal in curvature. Columella short, straight, with a median weak fold. Aperture oblique, posteriorly grooved.

Dimensions (in mm.) :—

Height of shell	80.8+	75.5+	65.5+	69+	76.5+	70+	76.5+	70+
Greatest diameter	28.2	31	29.5	30	31	39	30.5	30.5

Vicarya callosa japonica always has the tubercles extending horizontally from the axis of the shell, the upper part being flat and the lower inclined. In rare cases a groove is found to extend over the tips of the tubercles as in the typical *V. callosa*. The outer lip never extends above the subsutural tubercles of the lowest whorl. On the lower whorls are usually found two to three strong cords. The distance between the tubercles is not a constant feature because the shape of them and their number underlies some variation. In general the distance is greater in younger than in older whorls, due to the tubercles growing larger in the older whorls.

Localities :—

Dainitizaka, Uetuki-mura, Katuta-gun, Okayama-ken (Mimasaka), Reg. Nos. 62381 (type; R. AOKI coll.), 22423, 22430, 22431, and 58536 (I. SAGA coll.); Sara, Sarayama-mura, Kume-gun, Okayama-ken (Mimasaka), Reg. Nos. 4515 (collector not recorded), 22425 and 22428 (I. SAGA coll.); Miyauti, Syôbara-mati, Hiba-gun, Hiroshima-ken (Bingo), Reg. Nos. 22529 (T. OGURA coll.), 61087 (R. AOKI coll.); Inzyô, Tane-ga-sima, Kumake-gun, Kagosima-ken (Ryûkyû Islands), Reg. No. 49459 (S. HANZAWA coll.).

Remarks :—

The features of the aperture and lip are not fully preserved in our specimens, but according to T. TAKEYAMA's *V. callosa*, which is now regarded as synonymous with *V. callosa japonica*, the "columella short, straight, provided with a median weak fold. Aperture oblique, subovate, with a posterior groove and an anterior canal. Outer lip deeply sinuated at the lower band; below this sinus it is oblique, marginally reflected, expanded below and partly covers the canal. The canal is short, not reaching to the basal portion of the outer lip. Inner lip thickly callous, the callosity being very large and thick, extending above in the shape of a tongue up to just below the tuberculous band and leftward in a semicircle over the base".

Vicarya callosa japonica is distinguishable from *V. callosa* by the tubercles which are flat above and gently sloping below; in *V. callosa* the tubercles are gently sloping both above and below. From *V. verneuili*, the present subspecies differs in the absence of the auxiliary rows of delicate beads or knots.

Among the many specimens now referred to this subspecies, it is noticed that in only one specimen, a faint yet distinct groove extends over the tips of the tubercles as in the originally described *V. callosa*; this is shown in Pl. XXI (I), Fig. 31.

The spiral ridges aside from the one bearing the tubercles are generally two but there may be three on younger whorls and apparently do not become beaded. The number of tubercles range in number of 9-11 on the uppermost spiral cord.

Vicarya callosa yokoyamai (TAKEYAMA), 1933

Pl. XXI (I), Figs. 25, 27, 32, 37.

1933. *Vicarya verneuili yokoyamai* TAKEYAMA, Notes on the Genus *Vicarya*, with Descriptions of Two Japanese Forms. Jap. Jour. Geol. Geogr., Vol. 10, pp. 134-136, pl. 13, fig. 4.

This subspecies was first described by T. TAKEYAMA in the above mentioned article, in the following manner, namely:

Shell large, turreted, the apical angle being about 25° , with many whorls, of which the lower 13 are preserved. The whorls are flattish, regularly increasing, with a ratio of diameter to height of about 8 to 3, truncated conic in shape and separated by a linear distinct suture which ascends slightly in later whorls. Nepionic whorls, or about 8 upper whorls with diameters ranging from 5 to 15 mm., are ornamented with 4 nearly equidistant spiral cords. The uppermost cord, which is infra-sutural and is finely beaded, becomes gradually stronger on the later whorls, while on the last of the nepionic whorls it is nearly as strong as the lowest cord: the lowest cord, which lies a little above the lower suture, is the strongest of all, also finely beaded and nearly constant in its strength on the whorls; the 2 others are weaker than these cords and more finely beaded. The beads on the uppermost cord become gradually stronger and less in number on the first post-nepionic whorl, which is a transitional one to the adult whorls. The adult stage is represented by about 4 later whorls, on which the beads of the uppermost cord become much larger and had better be called spinous tubercles, thus giving the cord the appearance of a band with tubercles: the number of these tubercles is 8 or 9 on the last and penultimate whorls. The other 3 cords are as in the nepionic whorls, but another narrow, somewhat elevated spiral band is found, limited by the 2 middle cords. There appear besides a few secondary spiral striae between the cords and on the uppermost band with tubercles. Growth lines are fine and curved in the shape of an S and strongly incurved backward, with its maximum convexity facing backward and lying on the lower band and corresponding to the deep sinus on the outer lip. The last whorl is rounded at the periphery of the base which is a little convex and sculptured by a few spiral threads. Aperture slightly obliquely subovate, with a posterior groove and an anterior canal. Columella short, with a median weak fold. Outer lip with deep sinus corresponding to the lower band, in front of which it seems to be expanded. A thick callous covers the inner lip and extends above in the shape of a tongue up to just below the upper tuberculous band, and leftward in a semicircle on the base. The anterior canal is short. Height ca 97 mm.; diameter ca 36 mm. (Apical portion and outer lip partly missing).

Further he noted in the foot note that, "Its apertural characters are quite identical with those of *V. callosa*".

Dimensions (in mm.):—

Height of shell	83.5+	73.5+		79+	74+	66+	73+	73+
Diameter of shell	36	35.5	40.5	33	30	29	32	28.5

Vicarya callosa yokoyamai generally has a fairly broad short-conic shell, but a narrow elongate-conic shape is not a rare case among the specimens of this subspecies. The lowest cord which may be beaded, is very often worn to appear as if perfectly smooth, and in the large shells, a beaded cord is replaced by a smooth one. The cord which is limited above and below, is beaded and narrow as well as elevated, but may be as broad as the other and apparently smooth. It appears that the beading of the cords on the lower whorls may in part be due to the influence of the state of preservation, amount of wear in the living condition and partly to its local environmental factors.

Localities:—

Simizu-Matubora, Toki-mura, Toki-gun, Gihu-ken (Mino), Reg. Nos. 37125-37128 (I. SAGA coll.); Tuki-yosi, Akiyo-mura, Toki-gun, Gihu-ken (Mino), Reg. No. 38535 (I. SAGA coll.); Syômasama, Tuki-yosi, Akiyo-mura, Toki-gun, Gihu-ken (Mino), Reg. Nos. 27124 and 27134 (I. SAGA coll.), 27122 (H. YABE coll.); exact locality unknown, Gihu-ken (Mino), Reg. No. 16122; exact locality unknown, Etizen, Reg. No. 22425; Matugaya, Kokozura, Iwaki-gun, Iwaki, Reg. No. 22424 (I. SAGA coll.); Siogama, Siogama-mati, Miyagi-gun, Miyagi-ken (Rikuzen), Reg. No. 54378 (S. MABUTI coll.).

This subspecies was named *Vicarya semperi yabei* by I. SAGA in his manuscript. *V. callosa yokoyamai* was considered as a subspecies of *V. verneuili* by T. TAKEYAMA, and distinguished from it by, "the lowest spiral cord is beaded, that the narrow band between the upper

two spiral striae is elevated, and that the callous deposit is smaller". However, it appears that it is closer to *V. callosa* than to *V. verneuili*.

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***Vicarya callosa martini* SAGA (MS), subsp. nov.**

Pl. XXI (I), Fig. 29.

1917. *Vicarya semperi* var. *martini* SAGA, Report of the Geology of the Tertiary Formation of Eastern Mino, Op. cit., p. 21, fig. 2.

Shell fairly large, less heavy than foregoing forms, elongately conical, with many whorls, of which about the lower 13 are preserved. Whorls flat save for irregularities produced by spiral sculpture. Whorls with four to five spiral ridges of which the uppermost bears small beads on all except the last two whorls where the beads change into small tubercles; other four ridges arranged parallel to each other and separated by nearly equally distant interspaces, also provided with faint granulations which are wide apart; uppermost of these is close to uppermost cord which bears small beads; suture line rather deep. Small tubercles on last two whorls extend horizontally from axis of shell, their tops rather flat, but sloping below, triangular in top-view, much narrower than other interspaces but becoming about equal to them on last whorl; about 8-9 on a whorl. Base of last whorl provided with granulated striations. Young whorls provided with five spiral ridges of which the uppermost alone is finely beaded and the second from the lowest faintly granular. Columella short, straight; sinus apparently rather shallow.

Dimensions (in mm.):—

	(type)			
Height of shell	75+	82+	75.5+	54+
Diameter of shell	35	41.5	27	26

Vicarya callosa martini is provided with tubercles only on the lowest whorls where are found from three to four strong spiral cords which are granular in general. Variation to any considerable degree is not noticed in the specimens of this subspecies.

Localities:—

Simizu, Toki-mura, Toki-gun, Gihu-ken (Mino), Reg. No. 37120 (type, I. SAGA coll.), same locality, Reg. No. 62416 (S. MABUTI coll.); Syômasama, Tuki-yosi, Akiyo-mura, Toki-gun, Gihu-ken (Mino), Reg. No. 37125 (I. SAGA coll.); Siogama-mati, Miyagi-gun, Miyagi-ken (Rikuzen), Reg. No. 28173 (S. MABUTI coll.); Tukuyone, Wakasa-mati, Yazu-gun, Tottori-ken (Simane), Reg. No. 62417 (H. TANAKA coll.).

The present subspecies was considered to be a variety of *semperi* of Martin by I. SAGA in his manuscript. This form differs from *V. callosa japonica* and *V. callosa yokoyamai* by the last two or three whorls only bearing tubercles, while the rest consist of merely small beads. Also the tubercles or spines of the last two or three whorls are less developed compared to the above mentioned members. The number of spiral threads lying below the uppermost beaded cord are more numerous, the amount of callosity less and the sinus apparently shallower than in the above mentioned subspecies.

***Vicarya yatuoensis* sp. nov.**

Pl. XXI (I), Fig. 19.

Shell large, heavy, turreted, elongately conical, with only the last four whorls preserved. Whorls with four spiral parallel ridges of which the uppermost bears small, bluntly rounded tubercles, about equal to interspaces in width; second and third ridges granular, elevated, nearly equal to interspaces in width, fourth ridge narrower than interspaces, not granulated. Suture line incised and deep. Third whorl from the lowest with tubercles much enlarged, ridge granular, thread becoming less granular than that of fourth whorl and broader, fourth ridge becoming weaker; interstitial riblet found between third and fourth; second whorl with tubercles of first

ridge still larger than those of previously mentioned whorls, second ridge granular, third also granular, fourth becoming broad and interstitial riblet fairly strong and granular. Last whorl with first ridge with strong tubercles of about 12 in number, second ridge granular and separated from first by rather deep, squarish groove, as deep and broad as second ridge; third ridge forming shoulder, produced outwardly by about width of second ridge and meets upper portion of outer lip; three other ridges found below third one, these are rather weak, smooth, about equal to interspaces; growth lines sigmoidal; base with a few spiral ridges; columella short, straight with an incised groove posteriorly, aperture rather large, almost without callosity, sinus at inner upper part of outer lip shallow, but strongly callous above. Outer lip not preserved.

Diameter of lowest whorl 31, height from lowest whorl ca. 26.5, of second from lowest 10, third 8, of fourth from lowest 6.8 mms.

Localities:—

Takebata, Unohana-mura, Nehi-gun, Toyama-ken (Ettyū), Reg. No. 41228 (type, S. IMAMURA coll.); Zusahara, Kamimano-mura, Sōma-gun, Hukusima-ken (Iwaki), Reg. No. 28209 (F. SAITO coll.)

The present shell differs from *V. callosa japonica* in the sculpture of the whorls, less extensive tubercles and in the last whorl being shouldered instead of flat. *V. callosa martini* differs from the present one in the shape of the whorl and in the sculpture. *V. callosa yokoyamai* also differs from the present one in the shape and sculpture of the whorls. The tubercles of the present species resemble those of *V. callosa japonica* in being produced horizontally from the axis of the shell, but are much weaker and more delicate.

The Japanese species of *Vicarya*, as noticed from the foregoing localities are fairly well distributed in the Japanese Neogene, and are summarized in the following table.

Distribution of *Vicarya* in the Japanese Neogene

Locality	<i>V. callosa japonica</i>	<i>V. callosa yokoyamai</i>	<i>V. callosa martini</i>	<i>V. yatuoensis</i>
Tyōsen				
Nanseki, Meisen-gun, Kankyōhoku-dō ¹⁾	×	—	—	—
SW Japan; Inner Zone				
Miyauti, Syōbara-mati, Hiba-gun, Hirosima-ken	×	—	—	—
Senyo-mati, Zinseki-gun, Hirosima-ken ²⁾	×	—	—	—
Tōzyō-mati, Hiba-gun, Hirosima-ken ³⁾	×	—	—	—
Tukuyone, Wakasa-mati, Yazu-gun, Tottori-ken	—	—	?	—
Niimi-mati, Atetu-gun, Okayama-ken ⁴⁾	×	—	—	—
Sara, Sarayama-mura, Kume-gun, Okayama-ken	×	—	—	—
Uetuki-mura, Katuda-gun, Okayama-ken	×	—	—	—
Ayukawa-mura, Kōga-gun, Siga-ken ⁵⁾	—	×	—	—
Simizu-Matubora, Toki-mura, Toki-gun, Gihu-ken	—	×	×	—
Tukiyosi, Akiyo-mura, Toki-gun, Gihu-ken	—	×	×	—
Exact locality unknown, Hukui-ken	—	×	—	—
Takebata, Unohana-mura, Nehi-gun, Toyama-ken	—	—	×	×
NE Japan; Abukuma Mountainland and Sendai District				
Kadōno-mura, Iwaki-gun, Hukusima-ken ⁶⁾	—	×	—	—
Kokozura, Iwaki-gun, Hukusima-ken	—	×	—	—
Zusahara, Kamimano-mura, Sōma-gun, Hukusima-ken	—	—	—	×
Siogama-mati, Miyagi-gun, Miyagi-ken	—	×	×	—

1) Cited after J. Makiyama and Takeyama.

2), 3) and 4) Cited after Takeyama.

5) Cited after N. Ikebe.

6) Cited after M. Yokoyama.

The Palaeo-environment of *Vicarya*

It is a generally accepted fact that *Vicarya* is a genus characteristic of brackish-water, but as to sufficient data to uphold this view, we have no comprehensive work. In the following lines we wish to show, by enumerating the fauna found in association with *Vicarya*, that the brackish-water habitat is true.

In the Meisen district of North Tyôsen, we find *Vicarya* in the Heiroku beds,⁵²⁾ the lowest member of the Neogene sediments there, in association with the following fossils, namely:—

<i>Acila submirabilis</i> MAKIYAMA	<i>Cerithium meisensis</i> MAKIYAMA
<i>Anadara abdita</i> MAKIYAMA	<i>Clementia</i> sp.
<i>A. daitokudoensis</i> MAKIYAMA	<i>Corbula</i> sp.
<i>Batillaria yamanarii</i> MAKIYAMA	<i>Cyclina lunulata</i> MAKIYAMA
<i>B. tateiwai</i> MAKIYAMA	<i>Euspira meisensis</i> MAKIYAMA
<i>Cancellaria kobayashii</i> (YOKOYAMA)	<i>Joannisiella tateiwai</i> MAKIYAMA
<i>Cerithidea kampokuensis</i> MAKIYAMA	<i>Laternula</i> sp.
<i>Lucina meisensis</i> MAKIYAMA	<i>Solen</i> sp.
<i>Nassarius</i> cf. <i>kometubus</i> OTUKA	<i>Venerupis</i> (<i>Amygdala</i>) sp.
<i>Sealesia kurodai</i> MAKIYAMA	<i>Vicarya callosa</i> JENKINS of MAKIYAMA
<i>Pterorhytis</i> sp.	(= <i>V. callosa japonica</i>)

The Heiroku beds from which *Vicarya* was found, consists of false-bedded conglomerate cemented with medium sands, in addition to massive sandstone and mudstone with poor coal seams. In the beds, the most predominant fossils are said to be *Batillaria yamanarii*, *B. tateiwai*, *Cerithidea kanpokuensis*, *Anadara daitokuensis* and *Cyclina lunulata*. Of these species none are living, however, the genera are now found living in brackish-water conditions. Of the forms given in the above list, probably *Acila submirabilis* alone is not a form to frequent brackish-waters.

Together with the brackish-water genera as *Batillaria*, *Cerithidea*, *Cyclina* and others, the poor coal seams and stratigraphical distribution of the beds, all agree to the fact that the Heiroku beds are of brackish-water condition, at least they are not of a true marine facies.

In Tane-ga-sima, one of the many islands of the Ryûkyû Islands, *Vicarya* occurs from the Kukinaga beds,⁵³⁾ in association with the following fossils, namely:—

<i>Ostrea gigas</i> THUNBERG	<i>Taras semiasperoides</i> (NOMURA)
<i>Arca daitokudoensis</i> MAKIYAMA	<i>Cerithidea</i> cf. <i>cingulatum</i> (GMELIN)
<i>A.</i> cf. <i>abdita</i> MAKIYAMA	<i>Batillaria</i> cf. <i>zonalis</i> (BRUGUIERE)

The Kukinaga beds consists of alternating series of variegated conglomerate and sandstone with clay and some coal seams. *Vicarya* is said to occur in the clay part of the beds. The conditions under which *Vicarya* lived during the time of the deposition of the beds, closely resembles that of the Heiroku beds above referred to, not only in having brackish-water fossils, but also in the character of the sedimentary rocks.

In the province of Mino, *Vicarya* occurs in the Tukiyesi beds⁵⁴⁾ in association with the following forms, namely:—

<i>Yoldia sagittaria</i> YOKOYAMA	<i>Acila divaricata</i> (HINDS)
<i>Arca dalli</i> SMITH	<i>Venericardia</i> sp.
<i>Clementia vatheleti</i> MABILLE	<i>Cyclina sinensis</i> (GMELIN)

Dosinia japonica (REEVE)
Soletellina minoensis YOKOYAMA

Cerithium ishiiianum YOKOYAMA
Macoma tokyoensis MAKIYAMA

While at Matubora, another locality of the Tukiyesi beds with *Vicarya*, the following species have been reported, namely:—

Nuculana confusa (HANLEY)
Venericardia tokunagai YOKOYAMA
Cardium shinjiense YOKOYAMA
Macoma tokyoensis MAKIYAMA
Cultellus izumoensis YOKOYAMA
Natica janthostoma DESHAYES
Tympanotomus fluviatilis P. & M.

Pecten yessoensis JAY
Taras ustus (GOULD)
Cyclina sinensis (GMELIN)
Soletellina minoensis YOKOYAMA
Dentalium sp.
Turritella nipponica YOKOYAMA
Cerithium kobelti DUNKER

The Tukiyesi beds besides yielding abundant marine fossils, have in addition plant remains. The fauna as can be noticed from the cited lists, is not one of a typical open-sea nature, yet not one of a typical brackish-water one, yet it is one of a sandy or muddy environment, probably in the reach of brackish-waters, since such genera as *Tympanotomus*, *Cerithium*, *Cyclina*, *Macoma* and *Natica* are frequently found in such habitat of our recent seas.

In the Siogama district of Rikuzen province, *Vicarya* has been reported from the Upper shell-beds or the *Cultellus izumoensis* zone,⁵⁵⁾ from which the following marine shells are said to occur in association, namely:—

Arca trilineata CONRAD
Venericardia siogamaensis NOMURA
Cardium narusawaense NOMURA
C. shiobareense YOKOYAMA
Batillaria tateiwai MAKIYAMA
B. yamanarii MAKIYAMA

Lucina nuttallii CONRAD
L. k-hataii OTUKA
Epitonium nagaminense OTUKA
Cerithium otukai NOMURA
Cerithidea cingulata (GMELIN)

The Upper shell-beds is stated to consist of alternating layers of tuff and tuffaceous sandstone, rarely with conglomerate. From other localities of the same beds, the following are stated to occur, namely:—

Acila divaricata (HINDS)
Yoldia sp.
Arca trilineata CONRAD
Ostrea sp.
Siratoria siratoriensis OTUKA
Macoma incongrua (V. MARTENS)
Surculites siogamaensis NOMURA
Fulgolaria striata (YOKOYAMA)
Batillaria atukoe OTUKA

Nuculana confusa (HANLEY)
N. inermis (YOKOYAMA)
N. sp.
Pododesmus? sp.
Tellina iridella V. MARTENS
Panomya simotomensis OTUKA
Cancellaria kobayashii (YOKOYAMA)
Murex tiganourana NOMURA
Sinum yabei OTUKA

Vicarya is very rare in the Neogene deposits of the Siogama district, therefore, although the Siogama fauna may have been deposited in shallow muddy water of an enclosed bay, the environmental conditions at the time seem to have been unfavorable. Furthermore, the explanations to the rarity of the occurrence of this genus in the Siogama Miocene, are found in the fact that the northernmost limit in distribution is at this region on the one hand, and to the fact that the genus probably did not endure conditions serving for its flourishing.

In the Katuda district of Mimasaka province, *Vicarya* is reported from the Uetuki beds,⁵⁶⁾ a complex consisting of conglomerate and sandstone, and yielding such fossils as the following, namely:—

Anadara daitokudoensis MAKIYAMA

Batillaria tateiwai MAKIYAMA

Batillaria yamanarii MAKIYAMA

Besides the ones just listed, there also occur indetermined species of such genera as *Barbatia*, *Dosinia*, *Ruditapes* and *Strombus*. Also a number of manuscript names have also been listed as occurring in association.

The brackish-water condition of the Uetuki beds has already recognized by such authorities as J. MAKIYAMA, T. NAGAO and T. TAKEYAMA, and further comments seem to be unnecessary at this place.

In the Philippine Islands, according to W. D. SMITH,⁵⁷⁾

This species is moderately common in the Philippine coal measure shales, being especially plentiful in the shale above the principal coal seam on the eastern end of Batan Island, Albay Province. It is also found in the same position in the coal measures in Cebu and Mindanao.—Wherever the fossil has been found, it occurs in the gray shale just above the coal seams.

He also adds that the genus *Vicarya* in the Philippine Islands is of most importance in purposes of correlation.

The *Vicarya* recorded by W. D. SMITH⁵⁸⁾ from Lobo river in Bantangus province, is stated to be of nearly the same size as a specimen which he examined in the Tokyo Imperial University, and to be somewhat larger than those figured by K. MARTIN from Minanga and Dicomui brook in Northern Luzon. He identified his specimens with *Vicarya callosa* JENKINS var. *semperi* MARTIN. Subsequently, he⁵⁹⁾ figured another specimen from Batangus province, with the same remarks given in his previous report. His subsequent figure 4 appears to differ somewhat from his figures 6 and 7, and may be a front view of his previous figure. Figures 6 and 7 come close to what K. MARTIN described and figured as var. *semperi*, while his figure 10 is said to be *V. callosa* and not the variety.

More recently, R. E. DICKERSON⁶⁰⁾ figured three specimens of *V. callosa*, one from Tunnel No. 14, Sibuguey Peninsula in Mindanao and two from the East Batan coal seams in the Persevarancia claim, Batan Island. None of his specimens appear to be identical with those figured by W. D. SMITH, nor with the typical *callosa* which has been figured by H. M. JENKINS from Java. What the cause of such confusion is, cannot be said at this place owing to the want of specimens for study, and the question is left for some one who is in position to study them.

It appears that confusion among the Philippine specimens of *Vicarya* lies in the fact that more than one species is included into either the var. *semperi* or into what some authors call *callosa* on the one hand, and that more than one horizon with *Vicarya* is included into one merely on the fact that it occurs particularly above coal seams. Therefore, the problem although an interesting one, can only be analysed through additional knowledge on the stratigraphy of their respective occurrences.

For the sake of one who may again visit the known localities for further collections, the following ones are here mentioned.

Lobo River, Batangas Province, Luzon Island: Minanga on the right bank of the Catalangan and Dicomui brook both in North Luzon Island: Aringay, La Union also in North Luzon

Island: about 6 km west of Baguio and about 450 m south of Naguillian road in Benguet province of North Luzon Island: Sibuguey Peninsula in Mindanao Island: Tumaga river, Zamboanga in Mindanao Island: gray shale overlying the East Batan coal seam in the Perseverancia claim, Batan Island: Barrio Mesaba in Cebu Island: also presumably in Panay Island.

The foregoing occurrences of *Vicarya* in the Philippine Islands, even in the lack of knowledge of the associated fauna, clearly shows that the genus is certainly brackish-water in habitat. Similar brackish-water conditions are found in the Eocene of India, from where *Vicarya eocenica* COX,⁵⁸⁾ has been discovered. *V. eocenica* was found in the association with the following fossils, namely:—

<i>Amaurellina noetlingi</i> COX	<i>Cerithium?</i> <i>oldhami</i> COX
<i>Turritella harnaiensis</i> COX	<i>Pirena</i> (<i>Pseudobellardia</i>) <i>delphinus</i> (OPHEIM)
<i>Volutocorbis harnaiensis</i> COX	<i>Mytilus</i> (<i>Arcomytilus</i>) sp.
<i>Ostrea multicostata</i> DESHAYES	<i>Meretrix</i> cf. <i>villanovae</i> (HÉBERT & RENEVIER)
<i>O.</i> (<i>Crassostrea</i>) cf. <i>soudanensis</i> DOUVILLÉ	<i>Cardita mutabilis</i> D'ARCHIAC & HAIME

From the foregoing lists showing the various fossils which occur in association with *Vicarya*, it is readily noticed that the brackish-water condition or rather habitat or environment is true. Where the conditions are not typically brackish, as in the Siogama district, its occurrence is to be expected to be either rare or totally absent. However, in other regions where the conditions seem to have been really brackish, *Vicarya* is by no means a rare member. Probably water temperature may have also been one of the important factors governing the distribution of this genus in the Miocene seas of Japan, since we do not know of its occurrence in regions north of Sendai district of Rikuzen province.

As far as our knowledge is concerned, *Vicarya* is a genus that flourished in warm shallow brackish-waters of estuaries, partially closed inlets or in lagoons. It is a true Malayan element governed much by the water temperature and related considerably to the bottom material.

The Geological Age of *Vicarya* in Japan

As to the geological age of *Vicarya*, the oldest known representative of the genus occurs in the Eocene of India, and probably there are no precise records of its occurrence in the Oligocene, while as to the Miocene, we find that the maximum period of development is attained. Together with the maximum period of development of the genus, a large number of species or subspecies were given birth. As to the stages in development, it may be said that the spiral sculpture, from small beads only gradually developed into large spines in agreement with age, and finally when the largest spinuous sculpture was attained, the genus became extinct.

In Japan including North Tyôsen, the genus is found from various localities which have been considered by some authors as belonging to ages ranging from lower to upper Miocene in age. But, whether the ages of the respective beds or geological formations which have yielded *Vicarya* are really of different ages or of the same one, is a point of considerable debate, and as to our views, the following lines are given.

In the Meisen district of North Tyôsen, the Heiroke beds which have yielded *Vicarya*, have such species as *Anadara abdita*, *A. daitokudoensis*, *Batillaria yamanarii*, *B. tateiwai*, *Cancellaria kobayashii* and *Nassarius* cf. *kometubus* as a few of its extinct, yet interesting species.

These species are fairly widely distributed in the Japanese Neogene, and are now known from such localities as the Kukinaga beds of Tanegasima, Tukiyesi beds of Mino, Uetuki beds of Mimasaka and from the Upper Shell-beds of Rikuzen. The distribution is further extended to such regions as the Mutu province in northern Japan, Iwaki and Iwasiro of north of central Japan, and elsewhere.

Further, among the Meisen fauna we find that *Pitar itoi* MAKIYAMA is similar to *Clementia diaphana* CONRAD, *Dosinia sirakii* MAKIYAMA resembles *Dosinia nomurai* OTUKA, all of which are originally from the Japanese Neogene. Faunal similarity is also found in other species of the various beds so far enumerated.

From the standard of the Japanese Neogene now adopted by the writers it is to be noticed that *Vicarya* with all of its species, is restricted to the Japanese Miocene, and especially to the Middle part in a three-fold division, and to the lower part in the two-fold classification.

Remarks on Some Allied Genera from Japan

As stated in the earlier pages of this article, the *Cerithium baculum* YOKOYAMA (1923), from the Tertiary of Kii is different from the Mino *Vicarya baculum* YOKOYAMA (1926), although M. YOKOYAMA then considered it to be conspecific. The Kii *Cerithium baculum* and the Mino *Cerithium ishiianum* YOKOYAMA (1926), were recognized by T. TAKEYAMA as belonging to a genus which he named *Vicaryella*, which is a manuscript name subsequently used by N. IKEBE. Having recently obtained excellent specimens, which are referable to the manuscript genus *Vicaryella* of TAKEYAMA, the writers wish to supply additional data and to define as well as designate the genotype of *Vicaryella*, so it may become valid.

The Kii *Cerithium baculum* was referred to the genus *Clava* by T. TAKEYAMA, but subsequently N. IKEBE stated that T. TAKEYAMA established a manuscript genus *Vicaryella* to include such forms as the Kii *Cerithium baculum* and the Mino *Cerithium ishiianum*. However, T. TAKEYAMA's manuscript genus was not published in any of his works, although N. IKEBE has used it without designation of the genotype or definition of its limits. In such a procedure the genus is not valid. With some doubt, Y. OTUKA referred *Cerithium ishiianum* above mentioned to the genus *Proclava*, while M. YOKOYAMA maintained the genus *Cerithium*. "*Proclava*" *ishiiiana* (YOKOYAMA) of Y. OTUKA was subsequently renamed *Cerithium (Proclava) otukai* by S. NOMURA, on the grounds that Y. OTUKA's *ishiiiana* is not the same as YOKOYAMA's *ishiianum*; this point may be in need of comparison of the different specimens. Both T. NAGAO and J. MAKIYAMA recognized that the Kii *Cerithium baculum* and the Mino *Cerithium ishiianum* should be placed in a new genus, however, they did not establish a new genus for them.

In the following lines are given descriptions of the species of which the writers believe to belong to the genus *Vicaryella*, together with the definition of its limits. Probably other species will be found to belong to this genus by future study, but for the present, we may now mention three.

Genus *Vicaryella* TAKEYAMA (MS), gen. nov.

Genotype:—*Vicaryella tyosenica*, gen. et sp. nov. Reg. No. 62419.

Type locality:—Nanseki, Meisen District, North Tyōsen.

Definition:—Shell moderately large, turreted, with many whorls. The adult whorls ornamented with subsutural band bearing blunt tubercles or granules and spiral cords which may be granulated or smooth. Aperture with a posterior groove and short anterior canal. Columella pro-

vided with a strong fold which extends up into youngest whorls. Outer lip with double sinus which is nearly on level with base of last whorl, below reflected and provided with denticulations. Inner lip provided with rather large callous deposit. Canal short and extending to basal portion of the outer lip.

The genus *Vicaryella* was first made known through an article by N. IKEBE, who employs the manuscript genus name of T. TAKEYAMA to include such species as the *Cerithium baculum* YOKOYAMA from the Miocene deposits of Kii province and the *Cerithium ishiianum* YOKOYAMA from the Miocene deposits of Mino province. Subsequently, several authors have noticed that those two species require a new genus name, but refrained from establishing a genus in the view that T. TAKEYAMA had probably in preparation, such an article.

This genus resembles *Vicarya* in many respects, but is distinguishable from it by the double sinus of the outer lip, strong median fold of the columella, denticulation on the inner side of the outer lip, much less oblique aperture, and in the details of the sculpture of the shell. *Battilaria* (*Tateiwaia*), also resembles the present genus in general features of the shell, but lacks a median fold on the columella. *Cerithium* is another allied genus to the present one but the median fold on the columella, double sinus of the outer lip, strong callous deposit and tubercular sculpture seem sufficient for distinguishing it from the present one. *Proclava* is also related to the present one in several features, but the double sinus and denticulations of the outer lip, considerable callous deposit, and horizontal tuberculations of the sculpture seem to be features serving for their distinction.

The general habitat of this genus seems to have been one of brackish-water like that of *Vicarya*, and also coincident with that genus is the fact that the geological significance and associated fauna are remarkably similar.

The descriptions of the species now referred to the genus *Vicaryella* are given in the following pages, with a key to them as follows.

Key to the Species of *Vicaryella*

- Shell fairly large, suture deep and narrow, subsutural band bearing spinous tubercles, band immediately above suture rather flat and with minute granules; sculpture aside from subsutural band nearly uniform throughout shell length *tyosenica*
- Shell smaller than *tyosenica*, possessing adult sculpture of *tyosenica* only on younger whorls, lower whorls with smooth instead of granulated threads; suture concavely incised and smooth with no band immediately above *nipponica*
- Shell small, base of last whorl with about eight cords, suture ill-defined; tubercles of subsutural band small above and large below, four spiral cords below subsutural band which are smooth *bacula*
- Shell narrowly elongate, with tuberculated but not spinous subsutural band, spiral cords somewhat granulated and numbering about four *ishiana*

Vicaryella tyosenica, sp. nov.

Pl. XXI (I), Figs. 10, 23, 24, 30, 36, 39.

Shell of moderate size, elongately conical, many whorled, of which the last 8 are preserved. Whorls gradually growing, separated from one another by very narrow and deep suture which is always accompanied on its upper part by a beaded narrow band, subsutural band provided with spinous tubercles, other spiral sculpture consisting of beaded and granulated threads. Aperture large, canal recurved and open, inner lip with prominent and rather long denticulations, sinus shallow and not strong, columella nearly straight and provided with a single tooth or columella-fold extending spirally up into youngest whorls; callosity prominent. Of preserved whorls, youngest sculptured only with spirally arranged granulated threads numbering about four (par-

tially obliterated); next older or 7th, with subsutural band consisting of rather widely separate, strongly beaded sculpture, next two weakly beaded and third or one immediately above suture rather strongly beaded; 6th whorl from lowest with subsutural band developing small tubercles, other sculpture similar to next younger whorls; 3rd whorl with subsutural band provided with strong spinous tubercles with nearly flat interspaces, other three threads now represented by merely small beads which are apparently isolated from one another and connected by threads as in younger whorls and appear to develop from the shell directly; 2nd whorl with beaded band immediately above suture appearing as if with small tubercles instead of beads. Body whorl with about four to five weakly developed spiral rows of beads among which only three are well developed, the other two are faint threads, lowermost cord immediately above suture very strongly beaded and beads connected with one another by a strong cord which marks the base; base provided with about five to six spiral threads. Columella nearly straight, somewhat flaring, its posterior part incised with a groove, and the inner part with a single tooth which extends up into younger whorls, canal recurved and open; aperture *Vicarya*-like, squarely oblique in shape, extending to slightly above lowest suture line, slightly sinuated; outer lip provided with about eight or nine denticulations. Maximum diameter of shell ca. 14.5, height of preserved whorls ca. 41.4 mm.

This species is distinguishable from *Vicaryella nipponica* by the spiral sculpture, which aside from the subsutural band, is nearly uniform throughout, by possessing a narrower and deeper suture line, more pronounced spiral cord immediately above the suture, as well as by the larger shell attained in the adult stage.

In external sculpture, *Batillaria tateiwai* MAKIYAMA, a species originally described from the Heiroku beds of the Meisen district of North Tyôsen, resembles the present species, but the sculpture differs in detail and the present one has a tooth on the columella.

Variation in the sculpture of the specimens of the present species lies chiefly in the strength of the spiral threads.

Locality: Nanseki, Meisen District, North Tyôsen, Reg. No. 62419, (S. ENDO coll.) Nisatai, Nisatai-mura, Ninohe-gun, Iwate-ken (Mutu), Reg. No. 17715 (S. SHIMIZU coll.).

Vicaryella nipponica, sp. nov.

Pl. XXI (I), Figs. 11, 16, 17, 18.

Shell of moderate size, elongate-conic, with many whorls of which the lower 7 are preserved. Whorls gradually inclined, separated from each other by a well-defined suture which is concavely incised and smooth; sculpture consisting of beaded spiral cords on younger whorls and smooth threads on older. Subsutural band finely beaded in young whorls but becoming tuberculated in older one. Base of last whorl provided with well-defined spiral cords. Uppermost preserved or 7th whorl from the lowest, sculptured with two spirally beaded threads besides the more strongly beaded subsutural band; all three cords nearly equally spaced and connected with one another at positions of beads by longitudinal narrow bands. 6th whorl sculptured like 7th, but with beads of the subsutural band becoming gradually stronger, by elevation and appear as small rounded protuberances. 4th whorl with subsutural band still stronger compared to others and the other two spiral beaded cords attaining their maximum development. 3rd whorl with subsutural band provided with tubercles which extend from whorls rather convexly on upper and slopingly on lower side; other two spiral cords becoming less beaded than on younger whorls and developing weak spiral, smooth threads, one between the two and one between the lowest and the suture. 2nd whorl with four smooth, not strong spiral threads besides subsutural band which is provided with tubercles of the *Vicarya*-type. Body whorl provided with six smooth, not strong and nearly equally spaced spiral threads of which the lowest marks the base; subsutural band with prominent tubercles. Base with about six smooth spiral threads. Columella broken, preserved part rather straight and with a tooth. Maximum diameter of shell 11.5, height of preserved whorls 26.2 mm.

This species is distinguishable from *Vicaryella tyosenica* described in the foregoing by the smooth instead of granulated threads on the lower whorls, by having the adult sculpture of *tyosenica* only on the upper whorls, and also by a smoother shell in general.

In possessing the adult sculpture of *Vicaryella tyosenica* only in the upper whorls, *V. nipponica* evidently was derived from that species, either as an evolutionary descendant directly, or at least from the same stock.

Locality:—Tuetate, Kôyama-mura, Kawakami-gun, Okayama-ken (Bingo), Reg. No. 62420. (R. AOKI and T. SEKI coll.)

Vicaryella bacula (YOKOYAMA), 1923

Pl. XXI (I), Figs. 26, 33, 34, 35, 38.

1923. *Cerithium baculum* YOKOYAMA, Tertiary Fossils from Kii. Jap. Jour. Geol. Geogr., Vol. 2, No. 3, p. 52, pl. 6, fig. 12.

As already stated in the earlier pages of this article, the Kii *Cerithium baculum* and the Mino *Cerithium ishiiianum* have been placed in the genera *Cerithium*, *Clava* and *Proclava*. However, T. TAKEYAMA recognized that they are referable to none of the above mentioned ones and thus introduced a new genus name *Vicaryella* to include them. Unfortunately he gave neither description nor figures of the newly proposed genus, and in addition he did not designate nor define the type as well as draw the limits of the genus. As to the first knowledge of the genus, we have only a short sentence by N. IKEBE, who uses the manuscript genus name of T. TAKEYAMA; a procedure which seems to have caused some confusion.

The specimens now under consideration agree well with the figures and descriptions of the Kii *Cerithium baculum*, except for the features of the columella and aperture, which are not fully exposed nor well preserved in the type specimens of M. YOKOYAMA. Further difference between our *bacula* and the type *baculum* are found in the size of the shell which is larger in our material, and in the columella and base, which is much better preserved in our specimens. However, the presently studied specimens are in good agreement and are here identified with the Kii *baculum*, which is the originally described one.

The original description was given by M. YOKOYAMA in the following way:

Shell small, turrete, many-whorled. Whorls hardly convex, spirally sculptured. The sculpture consists of a subsutural row of spinous tubercles and somewhat unequal beaded cords, three on the penultimate whorl and usually one less on the preceding ones; while on the body-whorl they are many, being present down to the caudal end. The number of spinous tubercles is about ten on the last whorl. Periphery rounded. Base suddenly narrowed and furnished with about eight cords. Outer lip broken. Canal short, bent. Apical angle a little over 20°.

The present specimens are apparently better preserved than the one described by M. YOKOYAMA, and the following is the description.

Shell not large, elongate-conic, turreted, many whorled. 10 whorls preserved, straightly inclined, spirally sculptured and separated from one another by a narrow and ill-defined suture. Sculpture consists of a subsutural band bearing tubercles which are large in the lower and smaller in the upper whorls; tubercles bluntly rounded, separated from one another by narrower interspaces. Four spiral cords below subsutural band, apparently smooth, very narrow and considerably elevated; the lowest immediately above the suture and the highest immediately below the subsutural band, intercalary threads at time present. Base of last whorl provided with about eight cords. Columella short, slightly bent, provided with a significant fold or tooth, posteriorly incised with a groove; callosity moderate; outer lip broken, making shape of aperture unknown.

Vicaryella bacula besides occurring in the Miocene deposits of Nigisi in Kii province, the type locality, also occurs in the *Vicarya*-bed at Senyo-mura in Bingo province, and probably other localities will be found. N. IKEBE records this species from the Akebihara sandstone beds of Siga prefecture, but unfortunately he gave no figures of his specimens, and therefore the true nature of his specimens are unknown to the writers.

Although there are only four good and several fragmentary specimens in the collection studied, variation as to the number of threads, was not noticed.

Localities:—Nigisi in Kii province (type locality). Hanabuti, Senyo-mura, Sawayasu-gun, Hiroshima-ken (Bingo), Reg. No. 56497 (S. MABUTI, coll.)

"*Vicaryella*" *ishii*ana (YOKOYAMA), 1926

1926. *Cerithium ishii*anum YOKOYAMA, Molluscan Fossils from the Tertiary of Mino. Jour. Fac. Sci. Imp. Univ., Tokyo, Sec. 2, Vol. 1, Pt. 7, p. 218, pl. 28, figs. 11, 12.

The original description of this species, based upon several incomplete specimens from the Miocene of Mino province, was given by M. YOKOYAMA in the following way.

Shell moderate in size, highly turrete, many-whorled. Whorls flat with sutures not quite distinct, ornamented with spiral cords and striae; spiral cords four in number, subequidistant, the uppermost very near the upper suture, larger than the others, band-like, swelling into tubercles which number fourteen or fifteen in a whorl; next two cords beaded; the lowest smooth and close to the lower suture; striae simple and smooth, one between each two cords and also above the uppermost one. Periphery angulate, with a sharp spiral ridge below it surrounding the smooth, slightly concave base.

In describing the above species, M. YOKOYAMA has only "a single broken specimen and several casts," and although "The specimen lacks the upper whorls and the canal portion of the aperture. The apical angle of the spire is somewhat less than 20°, from which we can estimate that the number of the whorls was more than ten. The diameter of the shell seems to have reached about 13 millim., when judged from some of the casts".

In the present collection are a number of casts and one mould, together with a few in which a part of the shell matter is still attached, all closely agree with the figures and discription as presented by M. YOKOYAMA.

The reference of this species to the genus *Vicaryella* is open to question, particularly for the reason that the original description and figures do not reveal the characters of the columella, aperture and detail sculpture of the body whorl as well as that of the youngest ones. However, in the present procedure of referring it to the named genus, the writers are merely following the views previously expressed by T. TAKEYAMA, N. IKEBE, J. MAKIYAMA and T. NAGAO. Until good specimens of this species have been studied by the writers, they prefer to place the genus to which it is now referred in quotation marks to denote doubt.

Locality:—Tukiyosi, Akiyo-mura, Toki-gun, Gihu-ken (Mino), Reg. No. 17545 (I. SAGA coll.). Reported from Matubora and Tukiyosi, Gihu-ken (Mino), by M. YOKOYAMA.

Summary

1. The genus *Vicarya* was established by D'ARCHIAC and HAIME upon *Nerinea? verneuili* D'ARCHIAC, a Miocene species from India.

2. Discussions as to the generic value of *Vicarya* and as to its generic position have been given by K. MARTIN, W. H. DALL, W. D. SMITH, K. A. v. ZITTEL and recently by T. TAKEYAMA. Its position is now placed in the Potamidinae.

3. The following forms are now considered as valid in the genus *Vicarya*, namely, *ecocenica*, *verneuili*, *callosa*, *callosa japonica*, *callosa martini*, *callosa yokoyamai*, *yatuoensis* and probably *callosa semperi*.

4. *Vicarya* is a genus having species restricted in geographical distribution to the Far East, and ranging in time from the Eocene to Miocene, being best developed in the Lower or Middle Miocene, a time prior to its extinction which may be Upper Miocene, according to the usage of the term.

5. In the Japanese Miocene are found the following forms, namely, *callosa japonica*, *callosa yokoyamai*, *callosa martini* and *yatuoensis*; all are restricted to the Middle Miocene of Japan, and play an important role in the geological history and stratigraphical relationships of geographically isolated geological formations.

6. The manuscript genus *Vicaryella* of T. TAKEYAMA is here defined and thus made valid; the following species are now found to belong here, namely, *tyosenica* the genotype, *nipponica*, *bacula* and probably *ishiiiana*.

7. The habitat of both *Vicarya* and *Vicaryella* was one of brackish-water, at very shallow depths such as at the tidal zone, of warm water and particular nature.

8. From the associated faunules of both *Vicarya* and *Vicaryella*, it is found that their stratigraphical importance is nearly equal.

9. Keys to the species of both genera have been given in order to facilitate workers along this line.

10. Descriptions and figures of all known species of both genera are given.

Reference

- 1) D'ARCHIAC et M. J. HAIME, Description des Animaux Fossiles de Group Numulitique de l'Inde, p. 298, 1854.
- 2) D'ARCHIAC, Histoire de Progrès de la Geologie, T. 3, p. 286, 1850.
- 3) ZITTEL, K. A., Handbuch der Palaeontologie, Bd. 3, p. 249, 1881.
- 4) SMITH, W. D., The Essential Features of the Geology of the Philippine Islands. Phil. Jour. Sci., Vol. 5, p. 329, 1910.
- 5) FISCHER, P., Manuel de Conchyliologie et de Palaeontologie Conchyliologique, p. 681, 1887.
- 6) TRYON, G. W., Manual of Conchology, Vol. 9, p. 117, 1887.
- 7) MARTIN, K., Die Fossilien von Java, auf Grund einer Sammlung von Dr. R. D. M. VERBECK und ANDEREN 1891-1906. Samm. d. Geol., Reichs-Mus., Leiden, N. F., Bd. 1, p. 219, 1891.
- 8) DALL, W. H., in EASTMAN-ZITTEL, Text-Book of Palaeontology, Vol. 1, p. 550, 1913.
- 9) D'ARCHIAC, op. cit., p. 286, 1850.
- 10) HISLOP, S. Rev., On the Tertiary Deposit associated with Trap-Rocks, in the East Indies. Quart. Jour. Geol. Soc., Vol. 16, p. 177, 1860.
- 11) JENKINS, H. M., On Some Tertiary Mollusca from Mount Séla, in the Island of Java. Quart. Jour. Geol. Soc., Vol. 20, p. 57, 1864.
- 12), 13) WHITE, C. A., Contribution to the Paleontology of Brazil, comprising Descriptions of Cretaceous Invertebrate Fossils, p. 158, 1888.
- 14) MARTIN, K., Ueber Tertiär Fossilien von den Philippinen. Samm. d. Geol. Reiche-Mus., Leiden, Ser. 1, Bd. 5, p. 67, 1895.
- 15) WHITE, H. J. O., An Account of the Geology of the Isle of Wight. Mem. Geol. Surv. England and Wales, p. 17, 1921.
- 16) COX, L. R., A Contribution to the Molluscan Fauna of the Laki and Khirthar Group of the Indian Eocene. Trans. Roy. Soc. Edinburgh, Vol. 57, Pt. 1, No. 2, p. 44, 1931.

- 17) HILL, R. T., Geography and Geology of the Black and Grand Praries, Texas. 21st Ann. Rep. U. S. Geol. Surv., p. 161, 1901.
- 18) YOKOYAMA, M., Molluscan Fossils from the Tertiary of Mino. Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 1, Pt. 7, p. 219, 1926.
- 19) TAKEYAMA, T., Notes on the Genus *Vicarya*, with Description of Two Japanese Forms. Jap. Jour. Geol. Geogr., Vol. 10, pp. 137-140, 1933.
- 20) HISLOP, S., Op. cit., Vol. 16, p. 177, pl. 8, figs. 36 a-36 c, 1859. The original description of *Vicarya fusiformis* is, "N. testa fusiformi; aufractibus 10-12, planis, sutura lineari separatis, primis cingulis ornatis, ultimus laevibus; apertura parva, subquadrata, canaliculata; columella retroflexa; labro sinus insigni inciso, Long. 1.15; lat. 4 auc."
- 21) JENKINS, H. M., op. cit., p. 58, 1864.
- 22) The readers are referred to the article by T. TAKEYAMA, cited above.
- 23) HILL, R. T., Op. cit., p. 161, pl. 21, figs. 4, 5, 1901.
- 24) TAKEYAMA, T., Op. cit., p. 130, 1933.
- 25) COX, L. R., Op. cit., p. 44, pl. 1, figs. 7a, 7b, 8, 1931.
- 26) It should be noticed that the genus was described by both D'ARCHIAC and HAIME in a cooperative work, but the genotype species was described by D'ARCHIAC alone, in an earlier article.
- 27) TAKEYAMA, T., Op. cit., p. 140, 1933.
- 28) MARTIN, K., Op. cit., p. 67, 1895.
- 29) MARTIN, K., Die Gattung *Vicarya*, D'ARCHIAC. Samm. Reichs-Mus., Leiden, N. F., Bd. 2, Heft 6, 1917.
- 30) TAKEYAMA, T., Op. cit., p. 140, 1933.
- 31) JENKINS, H. M., Op. cit., pp. 57-58, pl. 7, fig. 5, 1964.
- 32) COSSMANN, M., Essais de Paléonchologie Comparée, L. 9, p. 164, pl. 9, figs. 1, 2, 1912.
- 33) BECKER, G. F., and K. MARTIN, Report on the Geology of the Philippine Islands. 21st Ann. Rep. U. S. Geol. Surv., Pt. 3, pp. 624-625, 1901. Here is given a full translation of the original description and remarks concerning *Vicarya callosa* JENKINS var. *semperi* MARTIN.
- 34) TAKEYAMA, T., Op. cit., 1933.
- 35) SAGA, I., Report on the Geology of the Tertiary Formation of Eastern Mino. Graduation Thesis of Inst. Geol. Pal., Tôhoku Imp. Univ., Sendai, 1917, 51 pp. In this article, particular attention is given to the genus *Vicarya* and its species as known up to 1917.
- 36) TAKEYAMA, T., Op. cit., pp. 137-140, 1933.
- 37) YOKOYAMA, M., Molluscan Remains from the Uppermost Part of the Jo-ban Coal Field. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. 45, Art. 5, p. 12, pl. 2, fig. 7, 1925 (not fig. 5 as cited by TAKEYAMA, which is *Solen gouldii* CONRAD of YOKOYAMA).
- 38) YOKOYAMA, M., Molluscan Fossils from the Tertiary of Mino. Jour. Fac. Sci. Imp. Univ. Tokyo, Sec. 2, Vol. 1, Pt. 7, p. 219, pl. 28, figs. 4, 5, 6, 1926 (not p. 217, pl. 27, figs. 11, 12, as cited by TAKEYAMA: p. 217 has only *Cylichna corpulenta*, *Siphonalia cassidaraeformis*, and *Buccinum leucostoma*, pl. 27 is not found in the cited article, and figs. 11 and 12 represent *Cerithium ishiiianum*, a species originally described in this article).
- 39) YOKOYAMA, M., Tertiary Fossils from Kii. Jap. Jour. Geol. Geogr., Vol. 2, No. 3, p. 52, pl. 6, fig. 12, 1923.
- 40) YOKOYAMA, M., Op. cit., Vol. 45, Art. 5, p. 12, pl. 2, fig. 6, 1925.
- 41) MAKIYAMA, J., Tertiary Fossils from North Kankyô-do, Korea. Mem. Coll. Sci., Kyoto Imp. Univ., Ser. B, Vol. 2, No. 3, Art. 8, p. 147, pl. 12, figs. 5, 6, 1926.
- 42) TAKEYAMA, T., Tertiary Stratigraphy of the Environs of Tanabe, Kii. Chikyû, Vol. 13, No. 2, pp. 104-105, 1930.
- 43) IKEBE, N., The Miocene of the Eastern Part of Koga-gun, Siga-ken. Chikyû, Vol. 22, No. 2, p. 123, 1934.
- 44) YOKOYAMA, M., Op. cit., Ser. 2, Vol. 1, Pt. 7, p. 218, pl. 28, figs. 11, 12, 1926 (These figures were erroneously placed in the synonymy of *Vicarya verneuili yokoyamai* by TAKEMURA, l.c.)
- 45) OTUKA, Y., Tertiary Structures of the Northwestern End of the Kitakami Mountainland, Iwate Prefecture, Japan. Bull. Earthq. Res. Inst., Vol. 12, Pt. 3, p. 624, 1934.
- 46) JENKINS, H. M., Op. cit., pp. 57-58, pl. 7, fig. 5, 1964; COSSMANN, M., Essais de Paléonchologie Comparée, Vol. 9, p. 163, pl. 9, figs. 1, a, 1912. The original description of *Vicarya callosa* is given in the text.
- 47) MAKIYAMA, J., The Neogene Period. Iwanami Manual in Geol. a. Pal., pl. 1, fig. 5, 1932.
- 48) The present writers feel certain that T. TAKEYAMA made several mistakes in citation of literature, and taking the mistakes as excusable, discussions are based on what that author evidently had in mind.
- 49) SAGA, I., Op. cit., 1917, has made a detail survey of the genus *Vicarya* (manuscript), and distinguished three forms in the Japanese Miocene, namely *Vicarya callosa* var. *japonica*, *V. sempri* var. *martini* and *V. martini* var. *yabei*. Further, he has discussed *V. verneuili*, *V. fusiformis*, *V. callosa*, *V. sapho*, *V. daphne*, *V. callosa* var. *sempri*, *V. branneri* besides described them in detail.
- 50) JENKINS, H. M., Op. cit., pp. 57-58, pl. 7, fig. 5, 1864.
- 51) COSSMANN, M., Op. cit., Vol. 9, p. 163, pl. 9, figs. 1, 2, 1912.
- 52) MAKIYAMA, J., The Meisen Miocene of North Korea. Mem. Coll. Sci. Kyoto Imp. Univ. Ser. B, Vol. 11, No. 4, 1936; Tertiary Fossils from North Kankyô-dô, Korea. Ibid., Ser. B, Vol. 2, No. 3, 1926.
- 53) HANZAWA, S., Topography and Geology of the Riukiu Islands. Sci. Rep. Tôhoku Imp. Univ., Ser. 2, Vol. 17, pp. 47-53, 1935.

- 54) YOKOYAMA, M., Molluscan Fossils from the Tertiary of Mino. Jour. Fac. Sci. Imp. Univ., Tokyo, Sec. 2, Vol. 1, Pt. 7, p. 215, 1926.
- 55) NOMURA, S., Miocene Mollusca from Siogama, Northeast Honsyū, Japan. Saito Ho-on Kai Mus., Res. Bull., No. 6, pp. 193-203, 1935.
- 56) MAKIYAMA, J., The Neogene Period, Iwanami Series in Geol. & Pal., pp. 43-44, 1932.
NAGAO, T., The Palaeogene Period, Ibid., pp. 39-40, 1932.
TAKEYAMA, T., Geology of the Tuyama Basin, Chikyū, Vo. 14. 1930.
- 57) SMITH, W. D., Contributions to the Stratigraphy and Fossil Invertebrate Fauna of the Philippine Islands. Philippine Jour. Sci., Vol. 8, Sec. A, No. 4, p. 268, 1913.
- 58) SMITH, W. D., Preliminary Geological Reconnaissance of the Lobo Mountains, Batangus Province. Ibid., Vol. 1, No. 6, pp. 628-629, p. 3, fig. 1, 1906.
- 59) SMITH, W. D., Contribution to the Stratigraphy and Fossil Invertebrate Fauna of the Philippine Islands. Ibid., Vol. 3, No. 3, p. 268, pl. 6, figs. 4, 6, 7, 8, 10, 1913.
- 60) DICKERSON, R. E., Review of the Philippine Palaeontology. Ibid., Vol. 20, No. 2, pl. 6, figs. 1a, 1b, 1c, 1922.
- 61) COX, L. R., A Contribution to the Molluscan Fauna of the Laki and Basal Khirthar Groups of the Indian Eocene. Op. cit., p. 27, 1931.
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EXPLANATION TO PLATE XXI (I)

(All figures in natural size)

- Figs. 1, 7, 8. *Vicarya eocenica* COX, 1931. The specimens are said to be from the Lower Ghazij shale (Middle Laki), Harnai, Baluchistan, India. The shell has no spines and is the oldest known one of the genus.
- Figs. 2, 3. *Vicarya callosa* JENKINS. Reproduced from M. COSSMANN, 1912. The specimen is said to be a plesiotype from Java, and is referred to the Pliocene by M. COSSMANN, which is probably an error.
- Fig. 4. *Vicarya callosa* JENKINS. Reproduced from H. M. JENKINS, 1863. This is the original figure, and the specimen is said to be from the Tertiary deposits of Mount Sela, Java.
- Figs. 5, 6. *Vicarya callosa* JENKINS. Reproduced from K. MARTIN, 1879-80.
- Fig. 9. *Vicarya callosa* JENKINS, var. *semperi* MARTIN. Reproduced from K. MARTIN, 1888-89. The specimen is said to be from Minanga, Catalangan in the Philippine Islands.
- Figs. 11, 16, 17, 18. *Vicaryella nipponica*, sp. nov. The specimens are from Tuetate, Koyamamura, Kawakami-gun, Okayama-ken. Reg. No. 62420.
- Figs. 10, 23, 24, 30, 36, 39. *Vicaryella tyosenica*, sp. nov. The specimens are from Nanseki, Meisen-gun, Kankyô-dô, Tyôsen. Reg. No. 62419.
- Figs. 12, 13, 21, 22. *Vicarya callosa japonica* SAGA (MS.), subsp. nov. The specimens are from Dainitizaka, Uetuki-mura, Katuta-gun, Okayama-ken. Reg. No. 62318.
- Figs. 28, 31. *Vicarya callosa japonica*, subsp. nov. The specimens are from the same locality.
- Figs. 14, 15, 20. *Vicarya verneuili* (D'ARCHIAC). Figs. 14, 20, reproduced from D'ARCHIAC and HAIME, 1853. Fig. 15, reproduced from M. COSSMANN, 1909. The genotype comes from "Calcaire grisâtre avec des grains de fer oxydé hydraté de la chaîne D'HALA", according to the authors.
- Fig. 19. *Vicarya yatuoensis*, sp. nov. The specimen comes from Yatuo, Nehi-gun, Toyama-ken. Reg. No. 41228.
- Figs. 25, 27, 32, 37. *Vicarya callosa yokoyamai* (TAKEYAMA). 25, a stone nucleus from Syômasama, Tuki-yosi; Reg. No. 58537. 27, a specimen from Simizu-Matubora; Reg. No. 37128. 32, 37, another specimen from Syômasama, Tuki-yosi in two different views; Reg. No. 37131.
- Fig. 26. *Vicaryella bacula* (YOKOYAMA). Reproduced from M. YOKOYAMA, 1923.
- Figs. 33-35, 38. *Vicaryella bacula* (YOKOYAMA). Three specimens from Senyô-mura referred to M. YOKOYAMA's species; Reg. No. 56497. 33 and 35 represent one and the same specimen in two different views.
- Fig. 29. *Vicarya callosa martini* SAGA (MS.), subsp. nov. The specimen is from Simizu-Matubora, Toki-mura, Toki-gun, Gihu-ken. Reg. No. 37130.



Kimura and Sinozaki: photo.