ON THE BIOLOGY OF LAND PLANARIANS

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(with 1 plate)

In the present paper are presented several biological observations on land planarians that my wife, Dr. Eudoxia M. Froehlich, and I have made while doing taxonomic work on these animals. The field observations are based on periodic excursions we have been doing since 1951 to the environs of the city of São Paulo, chiefly to the Horto Florestal and to the Jaraguá Mountain, lately also to the small wood at the new campus of the University; and on some larger excursions within the State of São Paulo, and to some other States of the Federation. We have also been trying to breed land planarians in the laboratory, but this is not so easy as with the freshwater ones, for at least some species (*Geoplana multicolor, G. burmeisteri,* and *G. taxiarcha*) with which we tried, refused to be fed with flesh, liver, or pieces of earthworms. We had to keep them on their natural diet of snails, slugs, etc., and it was not always possible to provide a constant supply of their food. As land planarians are also sensitive to heat, the terraria containing them must be kept in cool rooms, protected from direct sunlight.

Many of the data presented here confirm previous observations by several authors. The literature on the subject prior to 1899 is summarized in Graff's (1899) monograph. After this monograph, the principal papers and books that deal at some length on the biology of land planarians are those by Steel (1901), Graff (1917), Bresslau (1927 and 1933), Schirch (1929), Goetsch (1933), and Pantin (1950). Several and important data are presented in Marcus (1951)

Land planarians have practically no water-saving adaptations, being dependent upon the moisture they find in their environment.

On the other hand, they are sensitive to water, avoiding wet places. Ecologically they are, therefore, stenohygric hygrocoles. These characteristics compel them to remain hidden during the day in humid, but not wet, refuges, creeping out of these only at night, when the relative humidity of the air is high; but do not exclude them from quite dry situations (cf. Kennel in Graff, 1899, p. 246; Steel, 1901, pp. 564-5; and Bresslau, 1927, p. 221). We have found them, e. g., under stones in a burnt field, and under logs and fallen palm leaves in exposed sandy places near beaches. It is only exceptionally that they are found creeping by daylight, and this generally happens during or after rains, probably because they are expelled by the water from their refuges; or in shady, damp places in the forest. Sometimes, after rains or in the morning, they get to open places, where they find no new shelter, and end by drying up.

Both in the forest, and in more open places, land planarians are more easily found during the dry or winter season, i. e., approximately from April to September, when they can be found sheltered in the humid refuges under stones, fallen logs, etc. In the latter the worms and their egg capsules are also commonly found inside the galleries bored by insect larvae. The number of individuals, and even of species sometimes found in these shelters may be quite great (Bresslau, 1927, and Schirch, 1929 called them natural "traps"). In August, 1952, under a fallen log some 3 metres long, found in the wood at the Horto Florestal, we recorded, for example, over 10 specimens of *Geoplana goetschi*, 2 of *G. carinata*, 2 of *G. marginata*, and one of the following species: *G. itatiayana*, *G. phocaica*, *G. rosea*, *G. taxiarcha*, *Choeradoplana iheringi*, and *Xerapoa hystrix*. It is also during the winter months that their egg capsules are found in greater numbers. We have recorded a maximum in August-September, but from April on they are quite common. Some species produce egg capsules over several months. We collected, e. g., egg capsules of *G. multicolor* from March up to September, and of *G. carinata* from April up to October We have not yet seen egg capsules from December to February.

During the rainy, or summer season, approximately from October to February or March, land planarians are much more difficult to find, sometimes hardly found at all. Especially in wooded

areas, the chief reason for this scarcity is probably the high humidity available everywhere, making it unnecessary for the worms to retreat to the mentioned shelters, so that they remain dispersed. But probably also many worms, at least of some species, die at the end of their reproductive period, at the end of the dry or the beginning of the rainy season. On the whole, more observations are needed to a better knowledge of this aspect of the life of land planarians.

Some species of land planarians, *Geoplana vaginuloides* and *G. livia*, e. g., creep up the trees in the forest, and on rainy days or in moist places they are sometimes seen creeping on the trunks in daylight. A few species have been found inside the leaf rosettes of epiphytic Bromeliaceae, between the more external dead leaves, or above the water level in the central "aquarium" Ground species often take shelter into fallen Bromeliaceae.

Geobia subterranea, as the name implies, is a subterranean species, coming to the surface, at least during the day, only when driven out by rainwater. Some species of *Geoplana*, e. g. *G. goetschi* and *G. rosea*, and also *Issoca rezendei*, although not so thoroughly subterranean as *Geobia*, are also commonly found buried.

Several species of land planarians are "man-followers", being found both in towns and in the country. In the town they occur in gardens, backyards, vacant lots, and the like, under bricks, flower pots, refuse, etc. In the country they occur near houses, poultry-yards, pigsties, banana plantations, etc., under logs, fallen banana trees, or in places similar to those in the town. Some species seem to be restricted to these places, and among these are a number of introduced, or probably introduced ones. The following species are practically restricted to those places: *Bipalium kewense, Dolichoplana carvalhoi, Kontikia orana, Rhynchodemus hectori, Rh. scius, Issoca rezendei*, and *Geoplana burmeisteri*. We believe the first three to be introduced species, the last two, native. The two species of *Rhynchodemus* may be endemic or not. Some other endemic species of *Geoplana* occur commonly in the mentioned places, but are not restricted to them. These are *G. multicolor, G. quagga, G. tapetilla, G. pasipha*, and, also, *Geobia subterranea*.

The species of *Geoplana* generally creep with the anterior tip lifted up and making tactile movements from side to side as they advance. When creeping on dry substrates (some species also on too wet ones), they touch it only at some points (cf. Bresslau, 1933, p. 177 f. 171; Pantin, 1950, p. 28, pl. 2 f. 6-7; Marcus, 1951, pl. 31 f. 220), what results in saving mucus (or avoids wetting). On sufficiently moist substrates, they creep with almost the whole creeping sole in contact with the substrate. When the worms of some species are creeping rapidly, their hind ends seem to lag, and contract frequently to keep up with the movement. When alarmed, several species advance more rapidly by peristaltic waves similar to those of earthworms: waves of extension, followed by ones of contraction, begin at the anterior end and pass along the body to the posterior end. *Geoplana goettei* is the only species we know that, when alarmed, progresses rapidly by vigorous snake-like movements. *Geoplana bergi* has an unusually thin cephalic region and, when creeping calmly on an even surface, keeps it curled up, like a *Choeradoplana*. When alarmed, or when it gets to the edge of an object and meets no more "ground", the worm extends the cephalic end greatly, and surveys a relatively large space.

Some species of *Geoplana* when repeatedly stimulated mechanically (e. g., with a soft brush) at the cephalic end, creep backwards by muscular waves of extension and contraction similar to those described above, but beginning at the posterior end. This reaction is pronounced in some species, like *G. goetschi* and *G. rosea;* in other species, like *G. taxiarcha* and *G. phocaica,* it is weaker, showing itself only in the hind part of the body.

The species of the genera *Choeradoplana* and *Xerapoa* creep with the cephalic end curled up, the first presenting their glandular cushions, the second their distended sensory papillae. When alarmed, the species of *Choeradoplana* show a remarkable escape reaction (Pl. 1): they curve their hind ends up and forward until touching again the substrate; the rolling movement passes forward along the body, resulting in a kind of somersault. This somersaulting movement, which produces a rapid forward progression, is brought about by the very strong dorsal subepidermal longitudinal muscle layer. In *Choeradoplana* this muscle layer is stronger

than the ventral one, while the opposite condition is much more common in Geoplanids. The species of *Issoca* when creeping keep their sucker-like adhesive organ close to the substrate.

The food of land planarians comprises snails, slugs, earthworms, other land planarians, land isopods, insect larvae, and small arthropods like springtails, mites, etc. (Australian and New Zealandian species eat also larger insects and Peripatus, cf. Graff, 1899, and Steel, 1901) *Geoplana burmeisteri* and *G. carinata* eat a variety of species of snails, and also slugs of the family Limacidae. Small snails are eaten also by *G. chiuna, G. multicolor, G. pavani, G. vaginuloides* (cf. Riester, 1938, p. 72), and probably many other species. *G. multicolor, G. taxiarcha,* and *G. trigueira* were observed to prey on other land planarians. Land isopods are eaten by *G. marginata, G. caissara, G. tapetilla,* and *G. pseudorhynchodemus* (this species eats also small spiders and mites, Marcus, 1951, p. 78) Small arthropods, like springtails, mites, etc. are preyed upon by a number of small land planarians: besides *G. pseudorhynchodemus, G. trina,* species of *Xerapoa,* and species of *Rhynchodemus*. The sole specimen of *G. matuta,* when found inside a fallen epiphytic bromelia, was eating a flattened insect (probably Diptera) larva. One specimen of *G. tuxaua* was found sucking a beetle larva. *Geobia subterranea* and *Bipalium kewense,* as is already known, eat earthworms.

In the laboratory we succeeded in breeding a young specimen of *G. pavani,* collected by Prof. E. Marcus on August, 16, 1952 in the wood at Paranapiacaba, a locality some 30 Km. SE of São Paulo. The worm was kept in a large Petri dish with pieces of rotting wood and leaves, and fed with small snails. In the end of September it was sexually mature, and we fixed it on the first of October When collected, it was 28 mm. long by 3 mm. broad; preserved, 33.2 by 4.6 mm. During the 46 days it was kept alive, it ate 26 small snails. We have now been keeping for nearly five months, in large humid chambers with the same substrate referred above, specimens of *G. burmeisteri* and *G. marginata*. The former are fed with snails and slugs, the latter with land isopods.

When a snail-eating land planarian touches the body or the shell of a snail, it adheres with the anterior end to the prey It then creeps over and around the shell, usuall surrounding the shell

completely The pharynx now gets into position at the opening of the shell (the snail, if not already within, always retreats into it when attacked) and begins to suck the snail. When hungry, the land planarian generally cleans up neatly the shell; when well fed, it may leave half-digested remains. Some snails, when attacked, produce masses of froth, succeeding often, in this way, to ward off the land planarian. Slugs, and other land planarians are swallowed whole. When a slug-preying land planarian touches the body of a slug with its anterior end, it adheres to the prey and extends the body forwards, trying to get hold of the head of the slug, preventing the slug's escape. The slug, on the other hand, secretes on the whole surface a fluid mucus to counteract the adhesive glands of the planarian, and also begins to creep at full speed. Sometimes it manages to escape, but often the planarian succeeds in encircling its head and cutting off the retreat. The land planarian then creeps over the slug, keeping the body broadened and the margins closely adhered to the substrate in the region where slug is. When the slug is within reach of the pharynx, this is protruded, and the slug is swallowed. Land planarians are eaten in much the same way Once we put in a watchglass, to be fixed, one specimen of *Geoplana trigueira,* and one of *G. pseudorhynchodemus*. The former is a medium to large species, the second, a small and narrow one. Both were creeping on the glass, when the first touched with its cephalic end the posterior end of the second. Immediately the first extended rapidly the fore part of the body, the ventral side grooved, longitudinally over the smaller worm. This one broke into three or four pieces and began to disintegrate. The bigger worm crept on, and swallowed the fragments.

Species of *Rhynchodemus* use their cephalic hood to catch their prey On touching a springtail, e. g., the cephalic hood immediately adheres to it, and usually lifts it from the ground, thus preventing any successful attempt to escape. The springtail is then transferred to the mucus current of the creeping sole, and the worm creeps over the prey until the pharynx gets at it. The worm then stops and sucks the prey

The species (*G. marginata, G. tapetilla, G. pseudorhynchodemus, Rhynchodemus* spp.) we have seen preying upon arthro-

pods, did not swallow their prey, but only sucked it, leaving the empty, or nearly empty exoskeleton. Of land isopods we can see, after being sucked, only the dark gut. Some land planarians (*G. pseudorhynchodemus, G. trina,* species of *Xerapoa*), however, may swallow small arthropods, for they show in their guts remains of chitinous skeletons.

The secretion of the subepidermal glands of many land planarians is strongly injurious to the prey (possibly to some predator also, cf. Arndt & Manteufel, 1925, p. 346), which is often killed, and sometimes even disintegrated, shortly after being seized by a land planarian. Both the snail- and the arthropod-eating land planarians evidently present external digestion, sucking the more or less liquefied organs of their prey.

We have several times found worms copulating in the nature, what indicates that the usual manner of reproduction is sexual, with copulation and cross-fertilization. We do not know, however, if some species are not, at least occasionally, self-fertilizing, for some species seem to be so rare that we do not know how an individual could possibly find another, considering their restricted means of locomotion. Although land planarians have considerable powers of regeneration (Graff, 1899; Goetsch, 1933), we have observed reproduction by autotomy only in the exotic *Bipalium kewense* and *Dolichoplana carvalhoi*.

The individuals of some broad, flat species (*G. carinata* and *G. italiayana*) we saw copulating, had their whole ventral surface in contact, or only the anterior ends diverged (cf. Bresslau, 1933, p. 159 f. 151, 3) In a longer, more slender species (*G. marginata*), a pair we found copulating were in contact only in the region of the copulatory organs.

Egg capsules are laid by the worms in the moist refuges already referred to. About the number of egg capsules laid by a single individual, we have no data. The developement of the young within the egg capsule takes from two to three weeks, but the young may remain in the capsule for days or even weeks after they have completed their development (cf. Bresslau, 1927, p. 223) The following table presents the time egg capsules took to burst and liberate the young, and also the number of young. The column "collected" refers to the number of days egg capsules

collected in the field took to burst, the column "laid" refers to the number of days of those laid in the laboratory in a known date.

Species	collected	laid	N.º of young
Geoplana applanata		20	5
G. burmeisteri		15	7
"		28	1
G. carinata	36		2
"	41		2
G. goetschi		ca.30	4
G. quagga		24	4
G. tapetilla		15	3
Kontikia orana		17	4
Xerapoa hystrix		20	4

The egg capsules apparently burst at any place, having no preformed "lid and hole" (cf. Fletcher and Hamilton, and Dendy in Graff, 1899, p. 239) Sometimes the exit hole in circular or oval, but this seems to be due to chance, not to special structures. The number of young per capsule varied from one to ten. The number is variable also within single species, e. g., the number of young of 7 egg capsules of *G. burmeisteri* being respectively 1, 2, 4, 6, 7, 9, and 10. Similarly, from 6 egg capsules of *G. itatiayana* hatched respectively 1, 3, 3, 5, 8 and 10 young. In some species the variation in the number of young is smaller e. g., for *G. carinata* (12 egg capsules) the number has varied from 2 to 5 young; for *G. taxiarcha* (9 egg capsules), from 3 to 6. The size of the egg capsule is approximately proportional to the size of the individual, egg capsules of large specimens of *G. carinata* and *G itatiayana* being about 10 mm. in diametre. The young of most species are similar to the adults, but the colours are generally paler, and sometimes the colour pattern is simpler In some species, however, like *G. quagga* (cf. Marcus, 1951, pl. 22 f. 142) and *G. burmeisteri* (cf. Schirch, 1929, pl. 1 figs. 4, 5, 7, and 8; and Marcus, 1951, pl. 22 f. 138, and pl. 32 f. 231-2), the young present a different colour pattern from that of the adult worms.

REFERENCES

ARNDT, W. & MANTEUFEL, P. 1925. Die Turbellarien als Träger von Giften. Zeitschr. Morph. Oekol. Tiere, V. 3, pp. 344-357 Berlin.

BRESSLAU, E. 1927 Ergebnisse einer zoologischen Forschungsreise in Brasilien 1913-1914. Abh. Senckenb. Naturf. Ges. V. 40, pp. 181-235, pls. 24-25. Frankfurt a.M.

—— 1933. Tubellaria. W Kükenthal & Th. Krumbach, Handb. Zool., V. 2 Ist. half, pp. 52-293. Berlin & Leipzig (W. de Gruyter)

GOETSCH, W. 1933. Verbreitung und Biologie der Landplanarien Chiles. Zool. Jahrb. Syst., V. 64, pp. 245-288. Jena.

GRAFF, L. von 1899. Monographie der Turbellarien II. Tricladida Terricola. V. 1, xiii + 574 pp.; V. 2, 58 pls. Leipzig (Engelmann)

—— 1912-1917 Turbellaria. II. Tricladida. H. G. Bronn, Klass. Ordn. Tier-Reichs. V. 4, Pt. Ic, xxxviii + pp. 2601-3369, pls. 31-64. Leipzig.

MARCUS, E. 1951. Turbellaria Brasileiros (9) Bol. Fac. Fil. Ci. Letr. Zoologia n. 16, pp. 5-215, pls. 1-40. São Paulo.

PANTIN, C. F. A. 1950. Locomotion in British terrestrial nemertines and planarians, etc. Proc. Linn. Soc. London, Sess. 162 Pt. 1, pp. 23-37, pls. 1-2. London.

SCHIRCH, P. 1929. Sôbre as planárias terrestres do Brasil. Bol. Mus. Nacional, V. 5, pp. 27-38, pl. 1-4. Rio de Janeiro.

STEEL, Thos. 1901. Australian Land Planarians. Descriptions of New Species and Notes of Collecting and Preserving n. 2. Proc. Linn. Soc. N. S. Wales, V. 25, pp. 563-580, pl. 34. Sydney

Explanation of Plate I

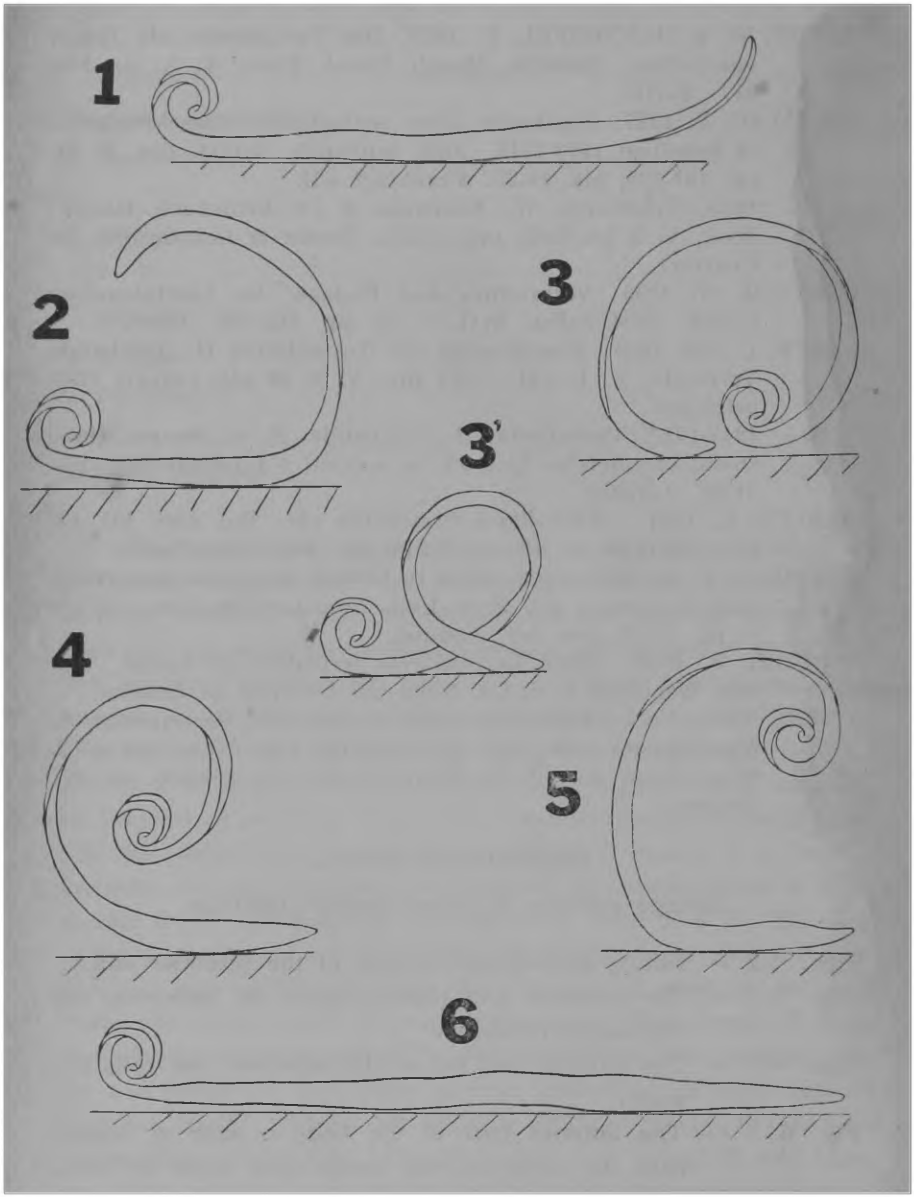
Escape reaction of *Choeradoplana marthae*

Figs. 1-2 — Lifting and rolling forward of the posterior end.

Figs. 3-3' — The posterior end touches again the substrate, two alternative positions.

Figs. 4-5 — The anterior end leaves the substrate and rolls forward.

Fig. 6 — The anterior part of the body is now in contact with the substrate, the worm may begin to creep normally, or it may begin another rolling movement (Fig. 1)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