ANNALES MUSEI ZOOLOGICI POLONICI
Tom XV Warszawa, 27 XI 1953 Nr 7

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O zaniku męskich narządów kopulacyjnych u ślimaków trzonkoocznych *(Stylommatophora)*, ze szczególnym uwzględnieniem *Retinella nitens* (MICH.)

Потеря мужского копуляционного аппарата у *Stylommatophora* с особенным учетом *Retinella nitens* (MICH.)

Male copulatory organs deficiency in the *Stylommatophora* with a special reference to *Retinella nitens* (MICH.)

[3 Text-figures and 3 Tables]

My study of the snail fauna from the environs of Kazimierz on the Vistula, Lublin voivodship, Poland, many a time called for anatomical examinations. I have studied among others the structure of reproductive organs of species belonging to the genus *Retinella* SHUTTL., and it is by this opportunity that I perceived in *Retinella nitens* (MICH.) the hermaphrodite reproductive organs being often deprived of the male copulatory parts. The interest I took in the causes of the atrophy of male organs and in its character induced me to study the matter more exactly.

My thanks are due to all those who helped me in performing my task, particularly to Professor Dr. St. FELIKSIAK, Director of the Polish Museum of Zoology, who supervised my work, as well as, to

Professor Dr. T. JACZEWSKI and to Professor Dr. Z. RAABE for their numerous and valuable advice and remarks.

The deficiency of male copulatory organs in *Stylommatophora* is a rather frequent phenomenon, often reported in malacozoological literature. SIMROTH, in his numerous papers (12, 13), describes the entirely female („rein weibliche") individuals of *Agriolimax laevis* (MÜLL.) completely lacking in male parts of reproductive organs. The occurrence of „female" individuals in the said species has likewise been confirmed by BABOR (1). IHERING (8) reports analogical cases for *Limax brasiliensis* SEMPER, which he calls a Brazilian substitute of *Agriolimax laevis* (MÜLL.) („brasilianischer Vertreter des *L. laevis*"). WIEGMANN (20) gives a brief information on the *Pupa muscorum* (L.), whose male genital organs have dwindled to such a degree, that the animal could function merely as a female („der männliche Geschlechtsapparat sich derartig verkümmert zeigte, dass das Tier functionell nur weiblich war"); similar phenomena were observed by the same author (7) in *Pyramidula rupestris* (DRAP.). STEENBERG (14, 15), BOYCOTT (3, 4) and WATSON (17, 18) have stated the atrophy of male genitalia in several species of the families *Vertiginidae* and *Valloniidae*: *Vertigo moulinsiana* (DUPUY), *V. substriata* (JEFFR.), *V. alpestris* ÅLD., *V. pusilla* MÜLL., *V. angustior* JEFFR., *Truncatellina rivierana* (BENS.), *T. britanica* PILSBRY, *T. costulata* (NILSS.), *T. cylindrica* (FÉR.), *Columella edentula* (DRAP.), *Chondrina avenacea* (BRUG.), *Acanthinula aculeata* (MÜLL.), *A. lamellata* (JEFFR.), *A. harpa* (SAY), *Vallonia pulchella* (MÜLL.), *V. excentrica* STERKI, *V. costata* (MÜLL.); in some of the examined species no specimens with fully developed hermaphroditic reproductive organs have been found thus far [Table 1]. Also, the lack of penis has been referred to in the brief note by THIELE (16) on *Acanthinula* BECK and *Vallonia* RISSO. Apart from that, COLLINGE describes sporadic cases of male organs absence in *Arion hortensis* FÉR. (13, p. 527), *Arion intermedius* NORM. and *Helix aspersa* MÜLL. (18, p. 276).

THIELE (16), likewise, mentions the absence of penis in certain *Arionidae* (*Arionidae* — „Penis gut entwickelt, bei anderen rückgebildet", *Aphallarion* PILSBRY et VANATTA — „ein Penis und Retractor fehlen", *Prophysaon* BLAND et W. G. BINNEY — „Genitalien ohne Penis", *Arion* FÉR. — „ein Penis fehlt"). However, the male ducts being here preserved, and vas deferens fully developed, this is merely the matter of a different male copulatory organs structure. SIMROTH (13, p. 523) asserts that in a large number of genera

TABLE I

List of species, in which the atrophy of male copulatory organs has been stated (the mark + indicates that the occurrence of the respective form has been stated without the number of the examined specimens being given)

Species	Investigator's name	The origin of the examined material	Number of specimens		
			euphallic	aphallic	hemiphallic
Vertigo moulinsiana (DUPUY)	WATSON	England	5	7	—
,, ,, ,,	STEENBERG	Denmark	+	+	—
Vertigo substriata (JEFFR.)	WATSON	England	0	5	—
,, ,, ,,	STEENBERG	Denmark	+	+	—
,, ,, ,,	STEENBERG	Ireland	+	+	—
Vertigo alpestris ALD.	WATSON	England	2	5	—
Vertigo pusilla MÜLL.	WATSON	England	0	17	—
,, ,, ,,	STEENBERG	Denmark	+	+	—
Vertigo angustior JEFFR.	STEENBERG	Denmark	3	24	—
Truncatellina rivierana (BENS.)	STEENBERG	Switzerland	2	1	—
Truncatellina britanica PILSBRY	WATSON	England	3	12	—
Truncatellina costulata (NILSS.)	STEENBERG	Denmark	2	1	—
Truncatellina cylindrica (FÉR.)	STEENBERG	Denmark	+	0	—
,, ,, ,,	STEENBERG	Germany	?	+	—
Columella edentula (DRAP.)	WATSON	England	6	0	—
,, ,, ,,	STEENBERG	Denmark	+	+	—
Chondrina avenacea (BRUG.)	STEENBERG	Germany	+	+	—
Acanthinula (A.) aculeata (MÜLL.)	STEENBERG	Denmark	+	+	—
,, ,, ,,	BOYCOTT	England	9	11	—
A. (Spermodea) lamellata (JEFFR.)	STEENBERG	Denmark	0	+	—
,, ,, ,,	BOYCOTT	England	0	20	—
A. (Zoogenetes) harpa (SAY)	STEENBERG	Sweden	0	+	—
Vallonia pulchella (MÜLL.)	WATSON	England	0	31	—
Vallonia excentrica STERKI	WATSON	England	0	22	—
Vallonia costata (MÜLL.)	WATSON	England	3	42	—
,, ,, ,,	STEENBERG	Denmark	+	+	—
Retinella nitens (MICH.)	RIEDEL	Poland	24	17	—
,, ,, ,,	RIEDEL	Ukrainien SSR	3	1	—
,, ,, ,,	RIEDEL	Bulgaria	1	1	—
Zonitoides nitidus (MÜLL.)	BAKER	USA	+	—	+
,, ,, ,,	WATSON	England	32	—	131
,, ,, ,,	WATSON	Canada	1	—	4
Zonitoides excavatus (BEAN)	WATSON	England	1	—	44
,, ,, ,,	WATSON	Holland	3	—	5

of the family *Arionidae* the penis proper does not exist; that what is in the respective literature called as a rule the penis, this author determines as epiphallus. It is also possible sometimes to note the truncus receptaculi (in *Geomalacus* ALLMAN) or the vagina (for instance in *Aphallarion* PILSBRY et VANATTA) playing the part of penis. It was only in exceptional, abnormal cases described by COLLINGE (13, 18), that the male ducts were entirely missing, the same as the receptaculum seminis. THIELE writes that penis is often atrophied („Penis kurz, . . . häufig rückgebildet") also in the genus *Thysanophora* STREBEL et PFEFFER (*Sagdidae*). According to PILSBRY (11) in *Thysanophora* (*Thysanophora*) *horni* (GABB.) the penis is remarkably short, while in *Thysanophora* (*Lyroconus*) *plagioptycha* (SHUTTL.) there is only a vestige of it; in the quoted species, too, the vas deferens is fully developed.

The above cited cases of the male ducts absence are not of the same character, on the contrary, we are dealing here with quite different phenomena. As far as the lack of penis in *Agriolimax laevis* (MÜLL.) is concerned, this feature has merely been noted in young individuals, in whose gonads eggs were present, while spermatozoa were missing (12). There was also stated the occurrence of intermediary forms having, appart from their complete female organs, a penis apparently yet not developed, in the form of a bud (1, 12). SIMROTH explains this phenomenon by the genital organs not simultaneously coming to maturity; in conformity with his opinion *Agriolimax laevis* (MÜLL.) attains maximum female development prior to male maturity, which means a phenomenon of protogynia. BABOR brings forward a hypothesis of successive sexual metamorphosis („Cyclus successiver Geschlechtsmetamorphose"); it consists in the animal being originally a female, next becoming hermaphroditic, and finally adopting again, under special conditions, a unisexual but for this time a male character. At any rate, the absence of penis in *Agriolimax laevis* (MÜLL.) would then bear just a temporary character being connected with individual development. This probably pertains also to *Limax brasiliensis* SEMPER.

With the species referred to in STEENBERG's (14, 15), BOYCOTT's (3, 4) and WATSON's (17, 18) papers the matter looks quite different. Here the penis deficiency has been noticed in full-grown forms, too; at the same time was stated the presence of spermatozoa in the gonads of individuals devoid of penis. It is clear from the above that the male deficiency is not connected with the phenome-

non of protogynia. BOYCOTT and WATSON are inclined to admit in these snails the self-fertilization as a normal way of reproduction.

As regards *Pupa muscorum* (L.) and *Pyramidula rupestris* (DRAP.) it is difficult to express any opinion whatever, for the brief WIEGMANN's notes (7, 20) do not allow to estimate the character of the phenomenon reported.

I do not know either what is the character of certain cases of peculiar genital organs structure in *Arionidae* and *Sagdidae*, being not acquainted with any specific papers dealing with the subject in question. Nevertheless, I consider it noteworthy to mention a somewhat different phenomenon observed in *Zonitoides nitidus* (MÜLL.). Not all the individuals of this species show the same degree of development as regards their copulatory organs; in some specimens they are normally and uniformly developed, whereas others have their male organs deficient, as if degenerated. THIELE (16) writes that in the subgenus *Zonitoides* sensu stricto the male and the female part of the genital organs in the majority of cases do not come to maturity at the same time. To BAKER (2), who discerns two stages — the male and the female phase, it seems probable that each of the individuals is permanently specialized towards one sex. When observing such a dimorphism of genitalia in *Zonitoides nitidus* (MÜLL.) and *Z. excavatus* (BEAN), WATSON compares it with the dwindling of the penis in *Vallonia* RISSO, *Acanthinula* BECK and *Vertigo* MÜLL. (19). He believes, that individuals with male organs fully developed reproduce normally through cross-fertilization, while those with the organs deficient have to reproduce by way of self-fertilization. For other British *Zonitidae*, WATSON did not report analogical cases; he presumes instead, on the grounds of BAKER's drawing and descriptions (2), that the genital organs dimorphism is likely to occur in certain American *Zonitidae*, such as, for instance, *Striatura ferrea* MORSE. In connection with this, it seems to me that a similar phenomenon may occur in the above quoted *Arionidae* and *Sagdidae*; the matter, however, requires exact testing.

WATSON defines individuals with degenerated male copulatory organs as hemiphallic, distinguishing them from the aphallic individuals totaly devoid of the male organs. He calls euphallic snails those having their genitalia fully developed. This terminology will be applied in the next part of the present paper. Moreover, I have to point out, that I am going to discuss here the atrophy of the male copulatory organs and not that of the reproductive organs.

In the case of penis and vas deferens missing, this is the decline of male copulatory organs which is concerned, not the male reproductive organs atrophy, the latter organs being present when a hermaphroditic gland, that produces both eggs and spermatozoa, exists.

I have noticed the occurence of aphallic forms, showing a lack of male copulatory organs, in the species *Retinella nitens* (MICH.)[1]. The examined material, preserved in the collections of the Polish Museum of Zoology, has been recorded in Table 2.

TABLE II

Retinella nitens (MICH.) — list of the examined material.

Locality, date, collector	Number of specimens	
	euphallic	aphallic
Skawa, Bieńkówka peak, distr. Myślenice, 23 VIII 1923, W. POLIŃSKI	2	0
Kazimierz on the Vistula, distr. Puławy, 30 IX 1949 R. BIELAWSKI	0	1
Kazimierz on the Vistula, distr. Puławy, 17 V 1950, A. RIEDEL	0	1
Kazimierz on the Vistula, distr. Puławy, 18—19 VIII 1950, B. PISARSKI	1	1
Kazimierz on the Vistula, distr. Puławy, 13—16 X 1950, A. RIEDEL	12	10
Kazimierz on the Vistula, distr. Puławy, 6—19 VII 1951, A. RIEDEL	1	2
Muszyna, distr. Nowy Sącz, 2 VIII 1951, A. RIEDEL	1	0
Piwniczna, distr. Nowy Sącz, 3 VIII 1951, A. RIEDEL	4	0
Sewerynówka near Szczawnica, 5 VIII 1951, A. RIEDEL	1	0
Pieniny: Czertezik peak, 6 VIII 1951, A. RIEDEL	1	0
Pieniny: Pustelnia, 7 VIII 1951, A. RIEDEL	1	0
Pieniny: Trzy Korony peak, 7 VIII 1951, A. RIEDEL	0	2
Ukrainien SSR — Podole, Buczacz, 17 IX 1922, W. POLIŃSKI	3	1
Bulgaria — Hwojna near Płowdiw, 15—18 IX 1950, M. MROCZKOWSKI and A. RIEDEL	1	1
Total	28	19

[1] I am using here the name *Retinella nitens* (MICH.) in HESSE's (6) meaning, such as was applied by him to the species characteristic for its long free oviduct („ungewöhnlich lange Uterushals"). The fully developed, euphallic copulatory apparatus of this species is represented in Fig. 1.

From among 47 specimens under study 19 were devoid of male copulatory apparatus, namely of penis, epiphallus and of a considerable part of vas deferens. Solely the upper portion of vas deferens was preserved, commencing at the free oviduct, just below the spermoviduct, and ending blindly with a slight swelling. The extremity of the oviduct was somewhat dilated, assuming a vaginal appearance. The typical atrium genitale was absent. However, I did not notice any difference in the female organs structure between the aphallic and the euphallic individuals (the difference in the shape of receptaculum seminis [fig. 1, 2 and 3] pertains to individual mutability

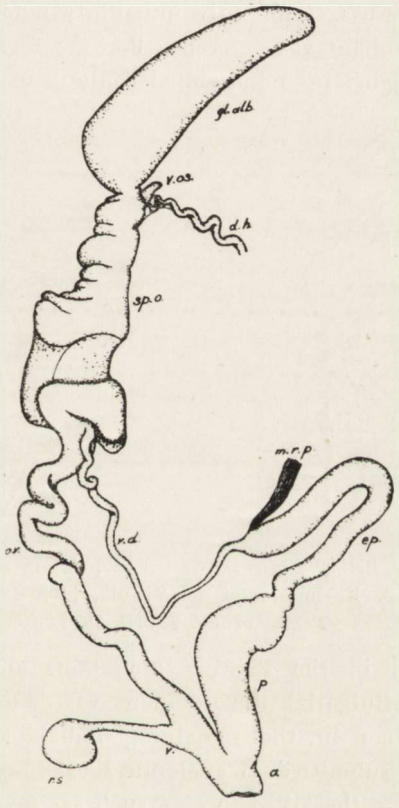

Fig. 1. *Retinella nitens* (MICH.); copulatory organs in the euphallic form. ×12. Kazimierz on the Vistula, 13 X 1950. a — atrium genitale, d. h. ductus hermaphroditicus. ep — epiphallus, gl. alb. — glandula albuminalis, m. r. p. — musculus retractor penis, ov — oviductus, p — penis, r. s. — receptaculum seminis, sp. o. — spermoviductus, v — vagina, v. d. — vas deferens, v. os. — vesicula ovoseminalis.

appearing both in the euphallic and the aphallic forms) I observed the presence of spermatozoa in glandula hermaphroditica and in ductus hermaphroditicus of the euphallic individuals; the spermatozoa were more numerous in the duct than in the gland proper. I failed to find spermatozoa in the receptaculum seminis.

Generally speaking, the above mentioned observations answer the character of the phenomenon described by STEENBERG, BOYCOTT and WATSON for some *Vertiginidae* and *Valloniidae*. I have met no intermediate forms between the euphallic and the aphallic type of organs; all the examined specimens either had hermaphroditic copulatory organs fully developed, or they were entirely devoid of the male copulatory parts. The only mutability noted pertained to the length of the remnant vas deferens. For the most part these variations were but slight; in 3 individuals only (2 of them coming from

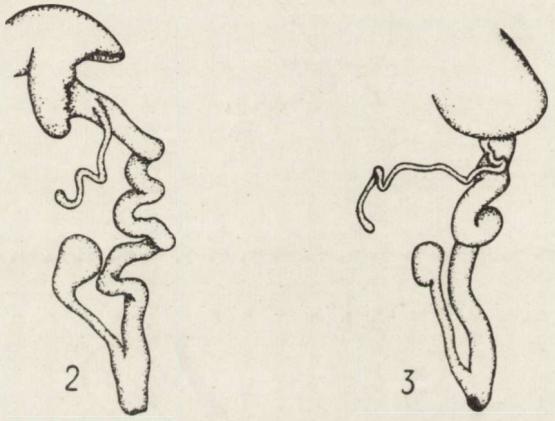

Fig. 2 and 3. *Retinella nitens* (MICH.): copulatory organs in the aphallic form; × 12. Fig. 2. Kazimierz on the Vistula, 14 X 1950. Fig. 3. Pieniny, Trzy Korony, 7 VIII 1951.

Trzy Korony peak in the Pieniny mountains and 1 from Hwojna near Płowdiw in Bulgaria) the remnant vas deferens proved considerably longer than in the remaining individuals [fig. 2 and 3].

I have also submitted to anatomical examinations several individuals from among the allied species, such as: *Retinella pura* (ALD.), *R. nitidula* (DRAP.) and *R. ressmanni* (WSTLD.) sensu BOECKEL, yet I have not noticed the absence of penis in these forms.

The penis of *Retinella nitens* (MICH.), if at all developed, is a large organ, easily noticeable on dissection; the supposition of its being overlooked or destroyed during preparation is out of the ques-

tion. However, to elucidate the causes of the male copulatory organs decline is not an easy task. The conjecture that the lack of penis induces sexual impotency should readily be rejected, on account of such a deficiency being extremely frequent in some species; in certain species even, no individuals with fully developed genital organs have been found thus far. It should therefore be admitted, that despite their incomplete copulatory organs, the aphallic forms are fit for reproduction.

The absence of the male copulatory organs is not a local phenomenon due to geographical agents, as specimens of *Retinella nitens* (MICH.) and almost all the species having aphallic individuals — were collected in various localities, often far distant from each other [Table 1]. Neither the phenomenon under discussion can be considered as seasonal, nor it should be explained as a not simultaneous maturity of the male and the female genital organs. STEENBERG, BOYCOTT and WATSON have studied the material gathered at different times, yet they have not recorded any dependence between the season of the year and the occurrence of aphallic forms. It is at the same time that the aphallic and the euphallic forms appear also in *Retinella nitens* (MICH.) [Table 3]. I likewise observed the absence of penis in mature as well as in young specimens having a shell about 4 mm. broad [1]), but whose genital organs were not yet mature. Hence, there are no grounds for a supposition that we are dealing here with a phenomenon of protandria or protogynia, as it probably occurs in certain *Limacidae*.

TABLE III

The occurrence of the euphallic and of the aphallic form in *Retinella nitens* (MICH.) in various months.

Month	Number of specimens	
	euphallic	aphallic
May	0	1
July	1	2
August	11	3
September	4	3
October	12	10

[1]) According to EHRMANN's measurements the shell of *R. nitens* (MICH.) is 8,5—9 mm. broad, the specimens measured by me being up to 8 mm. broad.

A partly solution of this interesting problem could be secured by means of breeding, which would eventually confirm the possibility (or necessity) of copulation. If among the aphallic individuals there takes place copulation, two alternatives arise: 1) the aphallic forms are functionally both male and female, the vagina then serving as an introductive organ. SIMROTH (13, p. 524) infers from the genital organs morphology, that in some *Arionidae* the vagina plays the part of penis; in that case, however, vas deferens is normally developed, contrary to the case under discussion where the latter organ is missing. Although there may exist a theoretical possibility of aphallic individuals being functionally bisexual, there is no evidence whatever of it. 2) The aphallic forms are functionally female only, and so, in consideration of the analogical „male" individuals missing, the euphallic forms should be recognized as males. It is also possible that the euphallic forms can function as males during the one-sided copulation with an aphallic individual, or they may remain functionally bisexual when copulating with another euphallic individual, in which case there takes place a normal cross-fertilization. Such an explanation of the phenomenon seems to be contested by the presence of spermatozoa in glandula hermaphroditica in individuals with penis missing. Nevertheless, as it has been stressed by BOYCOTT (4), in the animal world it may happen that the genital glands produce a certain quantity of gamets (in BOYCOTT's paper erroneously called „gonads") improper for the sex of a given individual. Moreover, BOYCOTT has stated in a single case, in *Acanthinula aculeata* (MÜLL.), the presence of spermatozoa in the receptaculum seminis of an aphallic individual; this hardly could be explained when excluding the conjecture, that they got there through copulation.

If the aphallic forms are apt to multiply without a foregoing copulation, this either is the case of parthenogenesis or of self-fertilization. Heretofore, parthenogenetic reproduction has been reported for *Prosobranchia* only, namely for *Paludestrina jenkinsi* SMITH and *Campeloma rufum* (HALDEMAN), in which species males are unknown (5). On the other hand, self-fertilization has been observed in numerous *Pulmonata*, both terricolous and freshwater ones, when single individuals were being bread in separation since their early youth to prevent the possibility of their copulation (9). In the case under discussion self-fertilization seems more probable, if it were only for the presence of spermatozoa in the gonads of aphallic forms; however, an ultimate answer may come solely from cytological investigations.

It should now be taken into consideration, what are the reasons of the atrophy of the copulatory organs in snails. According to BOYCOTT's hypothesis, the lack of male organs stands in connection with the poor locomotoric capacities of small snails (3, 4). He believes that such snails, due to their small dimensions, an extremely low motion tempo and their non—gregarious mode of living, have difficulties in meeting in the terrain, which results in their poor copulating chance. It is why they make the most of self-fertilization possibility as of their normal way of reproduction; thus the male copulatory organs atrophy, giving way to the development of other organs. WATSON (18) lays a particular stress upon the dwindling of less necessary organs to the advantage of the „more essential stuctures" development, which he explains as follows: the much complicated organs of snails are built out of a large amount of cells whose size cannot undergo an unlimited lessening. In connection with this, a stage may be attained, when the particular organs, which cannot become any smaller, become more and more condensed, and then it may be more advantageous for an organism to get rid of all superfluous organs which thus leave room for the normal functioning of the more important ones. When applying this hypothesis to small forms exclusively, WATSON refutes the objection liable to arise, which is, that certain species possessing the penis, like for instance *Vertigo pygmaea* (DRAP.), are smaller than those in which the absence of penis prevails; he thinks that in these relatively larger forms (like in *Acanthinula aculeata* (MÜLL.)) the male organs, if present, are particularly complicated, on account of which they occupy more space. Yet, against such a mechanistic way of dealing with the matter there arise certain objections: first of all, it is difficult to establish the importance priority in the animal organs; secondly, the cause here can hardly be discerned from the effect; that means, it is difficult to tell whether the development of the nerve knots causes the atrophy of the penis, or whether this is, on the contrary, the decline of this organ, due for instance to its not being used and thus degenerating, that influences the development of the central nervous system. My idea is, that these two actions have a parallel course, being in reciprocal dependence; the main reason, however, is probably due to ecological living conditions of these snails. Moreover, WATSON when asserting that the size of cells cannot be illimitably reduced, forgets another alternative — the decrease of the cells number. And yet it is well known, that in certain animals (*Rotatoria*) their complicated

organs consist of a relatively small number of cells, hence such a solution should also be taken into consideration. There is either no support for WATSON's assertion that in larger forms, in which there happens the atrophy of penis, the male organs, if at all developed, are particularly complicated; such is actually the case in *Acanthinula aculeata* (MÜLL.), yet the assertion should not be generalized. As *A. aculeata* (MÜLL.) measuring 2—2,3 mm. in width and 1,8—2,1 mm. in height is considered as a rather large form, *Retinella nitens* (MICH.) with its measurements of 9 mm. in breadth and 4,6 in height should be on this scale reckoned amongst giants; whereas in the latter form, too, it appeared that the penis was lacking, in spite of the simple male organs structure [1]). After the hemiphallism of *Zonitoides nitidus* (MÜLL.) and the aphallism of *Retinella nitens* (MICH.) have been stated, the phenomenon of male organs atrophy should no more be restricted to the particularly small forms, as this has been done by BOYCOTT and WATSON. After all, even if WATSON's hypothesis were to by admitted, a stipulation should be made that the development of the shell does not keep pace with the internal organs increase, which, if it were true, should occur in small and in large forms likewise.

Genarally speaking, it seems impossible to me to acknowledge one of these alternatives only as a sole and complete explanation of the phenomenon in question. There exist probably numerous reasons for the atrophy of male copulatory organs; evidently, many a reason having not yet been perceived they cannot be taken into account. As regards BOYCOTT's problem of the poor locomotoric capacities of certain snails (I am using the word „certain," as the aphallism should not be restricted to minute forms exclusively), they seem, indeed, an important agent. The main causes should, however, be assigned to ecological conditions, one of them being the scattering of individuals of a particular species all over the terrain, which possibly is due to some edaphic agent. The dispersion, as well as the slow motion tempo of snails, may actually prevent two individuals from meeting, which circumstance reduces their chance of copulating, all the more that the copulation period in snails does not last throughout their whole activity time (that is in spring, summer and autumn); as BOYCOTT points out (3), the period connected with reproduction matters is short in comparison with that the snail uses to secure

[1]) I am quoting here EHRMANN's measurements of the shell.

nutrition. As far as *Retinella nitens* (MICH.) is concerned, one of the causes of two individuals being handicapped in meeting is the micro-climate. *R. nitens* (MICH.) is an essentially southern species, moisture-loving, and it seems probable that somewhat drier spots of its proper biotope are a disadvantage which it cannot overcome, being thus limited in moving all over the terrain. The particular individuals may therefore live absolutely isolated. This matter should, however, not be simplified to a conclusion, that these snails, unable to meet, do not copulate and have to multiply through self-fertilization. Evidently, copulation takes place in the species in which euphallic individuals occur; there is merely a possibility that the meeting opportunity of two individuals presents itself not often enough, and in the course of time, the species is liable to decrease in number, which might lead to its dying out, if it were not for another multiplying possibility. Such an other „possibility" is offered by self-fertilization, sporadic cases of which have been many a time reported for the *Pulmonata*. In the case under discussion the reproduction by way of self-fertilization might be interpreted as a defence of the species against its dying out. In my opinion, a stress should be laid upon the fact, that not individuals but the species is concerned here; yet this was not mentioned in BOYCOTT's and WATSON's papers.

The whole problem could hardly be explained by self-fertilization being the sole means of multiplying. I presume, that, in its tendency to preserve its own existence, the species engages itself into a way of development that does not require copulation; however, the species does not resign it, trying only to secure itself another way of multiplying through self-fertilization in the case when two individuals are not likely to meet and copulate. Consequently, the male copulatory organs may for some reasons atrophy, this however, is no more essential from the point of vue reproduction. All the same, it seems to me that, in conformity with some particular conditions, reproduction may occur by various means, either through self-fertilization, or by way of copulation of an euphallic individual with an aphallic (or hemiphallic) one, — or alternatively, copulation may take place by the use of vagina of two aphallic individuals. From such a standpoint there would be an explanation to BOYCOTT's discovering spermatozoa in the vagina and in receptaculum seminis of the aphallic *Acanthinula aculeata* (MÜLL.). This also would elucidate the cause of the presence of receptaculum seminis in aphallic forms,

which organ, in the case of reproduction performed by way of self-fertilization exclusively, might seem unnecessary and would atrophy together with the penis; while, in fact, it still remains an organ performing its own normal function. Evidently, sole an experimental work based on breeding and observation can tell whether such a opinion is correct or not.

Anyhow, from my point of view, we are dealing here not with exceptional cases of degeneration in species, but on the contrary, with symptoms of their evolution tending to their better adaptation to the living conditions. Noteworthy is the fact, that all the species, in which there has been stated a total or partial atrophy of the male copulatory apparatus, belong to two groups of *Stylommatophora: Vertiginacea* and *Zonitacea*. Within these groups are also *Pupa muscorum* (L.) and *Pyramidula rupestris* (DRAP.), as well as the families *Sagdidae* and *Arionidae*, in which a similar phenomenon is also likely to occur. Moreover, there is to be noted in particular species a various degree of male organs decline, which seems to be a series of consecutive stages of such an atrophy: the euphallic, the hemiphallic and the aphallic forms, the latter with a remnant of vas deferens yet preserved, as well as the aphallic forms totally devoid of the said duct (in *Vallonia* RISSO). All this allowing a supposition that the atrophy of the male copulatory organs is characteristic not only of some particular species, but also of the entire groups *Vertiginacea* and *Zonitacea;* this also throws light upon their general way of developing. It seems very probable that this phenomenon occurs in snails much oftener than it has heretofore been observed, but in various species there may be found a different ratio between the aphallic and the euphallic forms.

It is difficult to state what is the course of this evolution of the particular groups of *Pulmonata*. As regards such a kind of phenomena as occur in *Agriolimax laevis* (MÜLL.) — two hypothesis have been brought forward: SIMROTH (11) considers this sort of phenomena as an evolution towards the sexual separation of hermaphrodites, which conjecture fails when admitting, in conformity with the prevailing opinion, that primarily the snails were dioecious, the hermaphroditism being a secondary feature [1]). BABOR (1) considers

[1]) SIMROTH's hypothesis can be adopted only when assuming that we are dealing here with the secondary dioecie which, however, has not been backed by any proof of correctness; no example of female genital organs atrophy has been known till now for hermaphroditic animals. Such an atrophy should have taken place simultaneously with the transition from the hermaphroditism into the dioecie.

another hypothesis; he asserts that this is just realizing hermaphroditic state by the snail. In the case under discussion, there are no grounds for such an opinion, as it is contested by the presence of the upper portion of vas deferens in the aphallic forms, which circumstance cannot be interpreted otherwise but as an existence of a remnant organ, a residue of the male copulatory organs. Yet, it seems possible that such snails from the groups *Vertiginacea* and *Zonitacea*, which have already realized their hermaphroditic state, proceed to self-dependence of the particular individuals with respect to reproduction.

Remarkable is the fact that only in the dioecious animals such an emancipation has hitherto been known. Two main tendencies are to be noted here: 1) the subordination of one sex to another, as this is the case with, for example, *Bonellia viridis*, certain *Cirripedia*, or fishes from the group *Ceratoidei;* such a submission leads, if not always, at least in particular cases to hermaphroditism (*Cirripedia*). 2) the freeing of female individuals from copulation by means of parthenogenetic reproduction, like, for instance, it occurs among insects in certain *Cynipidae*, *Aphidae* and others, and among snails in the aforementioned species of *Prosobranchia*. The same phenomenon of gaining independence being noted among the *Pulmonata* which are hermaphroditic animals, seems all the more interesting. Moreover, in the cases of parthenogenesis there occurs a complete elimination of the male sex, while in the case under discussion, provided self-fertilization actually takes place, the male reproductive organs persist, in spite of their being reduced to the group of cells of the hermaphroditic gland, which are producing spermatozoa. Yet, if in aphallic individuals the vagina cannot play the part of a male copulatory organ, the possibility arises of the aphallism leading to female one-sexuality. For, since the copulation is going to be totally excluded from the sexual process, mutual exchange of sexual elements will no more take place between two individuals, which may lead to spermatozoa loosing their normal importance; hence a probabilty that there will be no more fusion with the egg-cells. The role of spermatozoa would then be reduced to an incentive only, stimulating the development of non-fertilized eggs, and that would result in their complete atrophy. In such circumstances, there would occur a transition from self-fertilization into parthenogenesis, leading to the decline of the male parts of the genital organs, that is to female one--sexuality, which would mean the elimination of the male sex in the dioecious animals.

BIBLIOGRAPHY

1. BABOR J. F. Über den Cyklus der Geschlechtsentwicklung der Stylommatophoren. Verhandl. d. Deutsch. Zool. Ges., Leipzig, **4,** 1894.
2. BAKER H. B. Minute American *Zonitidae*. Proc. of the Acad. of Nat. Sci. of Philadelphia, Philadelphia, **80,** 1928.
3. BOYCOTT A. E. Preliminary note on the Genitalia of *Acanthinula lamellata* JEFF. J. of Conch., London, **15,** 6, 1917.
4. BOYCOTT A. E. The Genitalia of *Acanthinula aculeata*. Proc. of the Malac. Soc. London, **12,** 5, 1917.
5. COE W. R. Sexual differentation in Mollusks. II. Gastropods, Amphineurans, Scaphopods and Cephalopods. Quart. Rev. of Biol., Baltimore, **19,** 2, 1944.
6. FELIKSIAK St. Anomalies and deformations of the genital organs in *Helicigona (Arianta) arbustorum* (L.), with an attempt to explain the mechanism of their origin. Ann. Mus. Zool. Pol. Warszawa, **14,** 10, 1950.
7. HESSE P. Die Gattung *Hyalinia*. Nachrbl. d. Deutsch. Malak. Ges., Frankfurt a/M., **46,** 3, 1914.
8. HESSE P. Die systematische Stellung von *Pyramidula rupestris* DRAP. nebst Bemerkungen über einige verwandte Genera. Nachrbl. d. Deutsch. Malak. Ges., Frankfurt a/M., **50,** 3, 1918.
9. IHERING H. von. Zur Kenntniss der amerikanischen *Limax*-Arten. Jahrb. d. Deutsch. Malak. Ges., Frankfurt a/M., **12,** 1885.
10. LAMY E. La parthénogénèse chez les Mollusques. Journ. de Conch., Paris, **79,** sér. 4, 33, 1935.
11. PELSENEER P. Les variations et leur hérédité chez les Mollusques. Acad. Roy. de Belg. Mémoires, Bruxelles, sér. 2, 5, 1920.
12. PILSBRY H. A. Land Mollusca of North America, vol. 1, part 2. Acad. of Nat. Sci. of Philadelphia. Monographs. Philadelphia, 3, 1940.
13. SIMROTH H. Versuch einer Naturgeschichte der deutschen Nacktschnecken und ihrer europäischen Verwandten. Zeitschr. f. wiss. Zool., Leipzig, **42,** 2, 1885.
14. SIMROTH H. *Mollusca*. H. G. Bronn's „Klassen und Ordnungen des Tierreichs", Lieferung 126—138, Leipzig 1912.
15. STEENBERG C. M. Anatomie des *Acanthinula* et des *Vallonia*. Les organes génitaux. Vidensk. Medd. fra Dansk Naturhist. Foren., Copenhague, **69,** 1917.
16. STEENBERG C. M. Études sur l'Anatomie et la Systematique des Maillots (Fam. *Pupillidae* s. lat.). Vidensk. Medd. fra Dansk Naturhist. Foren., Copenhague, **80,** 1925.
17. THIELE J. Handbuch der systematischen Weichtierkunde, Teil 2. Jena 1931
18. WATSON H. The affinities of *Pyramidula*, *Patulastra*, *Acanthinula* and *Vallonia*. Proc. of the Malac. Soc., London, **14,** 1920.
19. WATSON H. Masculine deficiencies in the British *Vertigininae*. Proc. of the Malac. Soc. London, **15,** 6, 1923.
20. WATSON H. Genital Dimorphism in *Zonitoides*. J. of Conch., London, **20,** 2, 1934.
21. WIEGMANN F. Bemerkungen zur Anatomie der Clausilien. Jahrb. d. Deutsch. Malak. Ges., Frankfurt a/M., **5,** 1878.

STRESZCZENIE

Autor omawia zjawisko zaniku męskich narządów kopulacyjnych u *Retinella nitens* (MICH.) na tle notowanych już od dawna przypadków braku tych narządów u innych *Stylommatophora* oraz zastanawia się nad przyczynami i ewentualnymi konsekwencjami tego zjawiska.

Wyróżnia dwa zasadnicze rodzaje tego zjawiska u *Stylommatophora:* 1) czasowy brak męskiego aparatu kopulacyjnego, np. u *Agriolimax laevis* (MÜLL.), związany z protogynią, 2) trwały zanik narządów męskich, występujący między innymi u *Retinella nitens* (MICH.). Następnie, zajmując się tylko drugim przypadkiem, autor rozważa możliwości rozmnażania się form afallicznych dochodząc do wniosku, że prawdopodobnie zachodzi tu samozapłodnienie, co nie wyklucza jednak kopulacji osobników eufallicznych z afallicznymi. Przyczyn zaniku narządów męskich szuka w warunkach ekologicznych, w jakich żyją te ślimaki, utrudniających spotkanie się dwóch osobników w celu kopulowania.

Rozmnażanie przez samozapłodnienie wiąże autor z obroną gatunku przed zmniejszaniem się jego liczebności. Jednocześnie podkreśla, że omawianego zjawiska nie można uważać za objaw degeneracji gatunku, a przeciwnie należy je traktować jako objawy ewolucji w kierunku usamodzielnienia poszczególnych osobników pod względem rozmnażania.

РЕЗЮМЕ

Автор обсуждает: явление потери мужского копуляционного аппарата у *Retinella nitens* (MICH.) в связи с давно замеченной потерей этого аппарата у других *Stylommatophora,* причины и последствия этого явления.

Подчеркнуты автором два рода основных явлений у *Stylommatophora*: 1) временная потеря мужского копуляционного аппарата, например у *Agriolimax laevis* (MÜLL.) связанная с протогинией. 2) Постоянная потеря мужского аппарата выступающая между прочим у *Retinella nitens* (MICH.). Затем автор занимается только другим случаем и обсуждает возможность размножения афаллических форм и приходит к мнению, что вероятно является здесь самооплодотворение, что не исключает однако копуляции особей эуфаллических с афаллическими. Причины потери мужских органов автор ищет в экологических условиях жизни утрудняющих встречу особей для копуляции.

Автор связывает размножение через самооплодотворение с обороной вида пред уменьшанием его численности.

Одновременно подчеркивается что обсуждаемое явление нельзя считать признаком дегенерации вида, а наоборот проявлением эволюции в направлении приобретения самостоятельности отдельных особей с точки зрения размножения.

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