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Rewizja palearktycznych form z rodzaju *Discus* FITZINGER, 1833 (*Gastropoda, Endodontidae*)

Ревизия палеарктических форм рода *Discus* FITZINGER, 1833 (*Gastropoda, Endodontidae*)

Revision of the Palearctic forms of the genus *Discus* FITZINGER, 1833 (*Gastropoda, Endodontidae*)

[Pl. III—IV, 1 text-figure, 3 maps and 5 tables]

HISTORICAL ACCOUNT

The names *Gonyodiscus* and *Discus* were used for the first time by FITZINGER (1833) for two different genera. GRAY (1847) fixed *Helix perspectiva* Meg. v. MÜHLFELD as a type species for *Gonyodiscus* FITZ., and *Helix ruderata* HARTMANN[1] as a type species for *Discus* FITZ. HELD (1837) established the genus *Patula*. As a type species for that genus HERMANNSEN (1847) designated *Helix rotundata* O. F. MÜLLER. H. & A. ADAMS (1858) in their first revision of that group joined these genera into one, using for it the name *Discus*. A nomenclatorically valid and correct name is therefore *Discus* FITZ., the other two (*Gonyodiscus* FITZ. and *Patula* HELD) being its synonymes. That name was used consequently by THIELE (1931), BAKER (1948), FORCART (1957) and many others. BAKER, PILSBRY and FORCART based their opinions as to that matter on the cited literature and on the International Rules of Zoological Nomenclature.

Misinterpretations:

WESTERLUND (1889) used the names *Discus* FITZ. and *Gonyodiscus* FITZ. for two equal groups of the subgenus *Patula* HELD. Besides, he spelled "*Goniodiscus*" instead of the correct form *Gonyodiscus*.

PILSBRY (1894) placed the whole group in question as "sectio *Gonyodiscus* FITZ." in the genus *Pyramidula* FITZ. and subgenus *Pyramidula* s. str. Subsequent studies of WAT-

[1] Till recently STUDER was regarded as the author of that species. FORCART (1957) wrote: "Der Artname *ruderatus* wurde erstmals von STUDER (1820: 86) als *Glischrus* (*Helix*) *ruderata* ohne Beschreibung publiziert und ist als nomen nudum nomenklatorisch ungültig. HARTMANN (1821: 231, Taf. 2 Fig. 11) publizierte ihn erstmals nomenklatorisch gültig als *Helix ruderata*. HARTMANN ist deshalb Autor der Art."

SON (1920) had shown definite differences between *Discus* FITZ. and *Pyramidula* FITZ. In fact these differences were big enough to include *Discus* FITZ. into the superfamily *Sigmurethra*, and *Pyramidula* FITZ. into the superfamily *Orthurethra*.

TAYLOR (1909) assigned *P. rotundata* MÜLL. to the genus *Pyramidula* FITZ. and subgenus *Discus* FITZ.

LINDHOLM (1927) in the nomenclatorical considerations erroneously regarded *Gonyodiscus* FITZ. as the right name.

The same name, spelled "*Goniodiscus*" was used later by GEYER (1927), EHRMANN (1927), LIKHAREV & RAMMELMEIER (1952) and by some other writers.

Subgenera

As regards the division of the Palearctic forms of the genus *Discus* FITZ. into subgenera there is a considerable diversity of opinions.

WESTERLUND (1889) divided these forms into two groups: 1. *Discus* FITZ., including the species "*H. rotundata* MÜLLER" and "*H. ruderata* STUDER"; 2. *Goniodiscus* FITZ., with the species "*H. solaria* MENKE". The basic difference was the acute or obtuse keeling of the last whorl.

GEYER (1927) divided the genus *Goniodiscus* FITZ. into subgenera *Discus* FITZ., including the species "*G. rotundatus* MÜLL." and "*G. ruderatus* STUD.", and *Goniodiscus* s. str., including "*G. perspectivus* Meg. v. MÜHLF." without any further motivation. In the key to species the maculated or unicolor shell and the presence or absence of a keel on the last whorl were regarded by him as the distinguishing characters.

LINDHOLM (1927) did not divide the genus *Gonyodiscus* FITZ., yet suggested the possibility of splitting it into two subgenera. One of them would be *Gonyodiscus* s. str. with maculated shell and west- and middle-european distribution. The other would be *Discus* FITZ. with unicoloured shell and Holarctic distribution.

THIELE (1931) distinguished seven "sectiones" in the genus *Discus* FITZ., among others *Discus* s. str. and *Gonyodiscus* FITZ. The definition for *Discus* s. str. is: "Schale einfarbig...", for *Gonyodiscus* FITZ.: "Schale braunfleckig, sehr weit genabelt...". Thus *Discus ruderatus* HARTMANN would belong to *Discus* s. str., *Discus rotundatus* MÜLLER and *Discus perspectivus* MÜHLFELD would belong to *Gonyodiscus* FITZ.

PILSBRY (1948) divided *Discus* FITZ. into subgenera *Discus* s. str., *Gonyodiscus* FITZ. and *Nematodiscus* PILSBRY, the latter with only one Nearctic species. BAKER (in PILSBRY, 1948) stated that the distinguishing character for *Gonyodiscus* FITZ. was: "Penial retractor from the columellar muscle", and for *Discus* s. str. "Penial retractor from diaphragm". FORCART (1957) wrote: "Weder BAKER noch PILSBRY teilen mit, ob bei nearktischen Arten festgestellt wurde, dass sich der Penisretraktor mit der Columellarmuskulatur vereinigt. Vermutlich wurde diese Angabe Soós (1917: 119 — 120, 161 — 162) entnommen, der von *Discus perspectivus* — den er unter dem Synonym *Patula solaria* (MENKE) beschrieb — mitteilte, dass sich der Penisretraktor mit der Columellarmuskulatur vereinige.". Next he concluded from his anatomical studies that Soós was mistaken. The penial retractor in *Discus perspectivus* (MÜHLF.) is connected with the diaphragm in the very same way as in *D. rotundatus* (MÜLL.) and in *D. ruderatus* (HARTM.). My own anatomical studies of numerous specimens of *D. perspectivus* (MÜHLF.) and of other *Discus* FITZ. species have fully confirmed this view. So we come to the conclusion that the character, used by BAKER (in PILSBRY, 1948) as the basis of distinction, simply does not exist.

FORCART (1957) in his detailed and profound study demonstrated that other characters (like keeling of the body-whorl, shell coloration, dimensions of the umbilicus or shell or the number of whorls) are equally insufficient for setting up the definition of superspecific taxonomical units. That view seems to be justified by the fact that the group in question is well known for its considerable individual variability of the shell. This variability was pointed out among others by BOETTGER (1929, 1930, 1931) and will be also discussed in

the present paper. Finally Forcart assumed that there was no ground for grouping the Palearctic *Discus* species into different subgenera. For the then state of knowledge this assumption was fairly reasonable.

TAXONOMY

In my anatomical studies on the Palearctic species of *Discus* Fitz. I have found differences in the structure of the genital organs which I believe to be of taxonomical value. Some of them have already been known and mentioned e. g. by Hesse (1915). Consequently, I regard the following as the proper taxonomical arangement of that group:

Genus *Discus* Fitzinger, 1833

Subgenus *Discus* s. str.

Discus (*Discus*) *ruderatus ruderatus* (Hartmann, 1821) (type species)
Discus (*Discus*) *ruderatus pauper* (Gould, 1858)

Subgenus *Gonyodiscus* Fitzinger, 1833

Discus (*Gonyodiscus*) *perspectivus* (Megerle von Mühlfeld, 1816) (type species)
Discus (*Gonyodiscus*) *rotundatus* (O. F. Müller, 1774)
Discus (*Gonyodiscus*) *rotundatus* forma *abietina* (Bourguignat, 1864).

The penis in the subgenus *Discus* s. str. has the form of an elongated cone. The narrow top of that cone communicates with the genital atrium, the big, rounded basis forming the distal end[1]. The penial retractor runs from the diaphragm exactly to the middle of that basis, the connection being thus terminal. The vas deferens joins the penis laterally, at one side of the mentioned "basis" [Pl. III, Figs. 1 — 4].

In *Gonyodiscus* Fitz. the penis is cylindrical, much elongated too. The penial retractor is attached to the penis laterally. The place of attachment falls between one fifth and one third of the length of the penis from its distal end. The vas deferens connects with the penis at the distal end of penis i. e. terminally [Fig. 1; Pl. III, Figs. 5, 6].

The prostata (the masculine part of the spermoviduct) shows marked differences between the two subgenera as well. In *Discus* s. str., according to Hesse (1915), "...die Prostata aus einem schmalen acinösen Bande besteht". Moreover the prostata is very slightly divided into small folds. Proximally it is narrowing gradually so that there is no sharp boundary between prostata and vas deferens. In its form the prostata is distinctly elongated [Pl. III, Figs. 7, 8].

[1] The terms "proximal" and "distal" in the case of the genital organs, are related to the genital orifice in the epidermis, taken as the base of orientation. The parts of the organs, situated nearer to the genital orifice are characterized as proximal, those situated more distantly as distal.

In *Gonyodiscus* Fitz. the prostata is triangular or semicircular in shape. It is broad and divided by deep furrows into big, distinct folds. Vas derefens is separated from it very distinctly, sometimes coming out from between two such folds [Fig. 1; Pl. III, Figs. 9, 10].

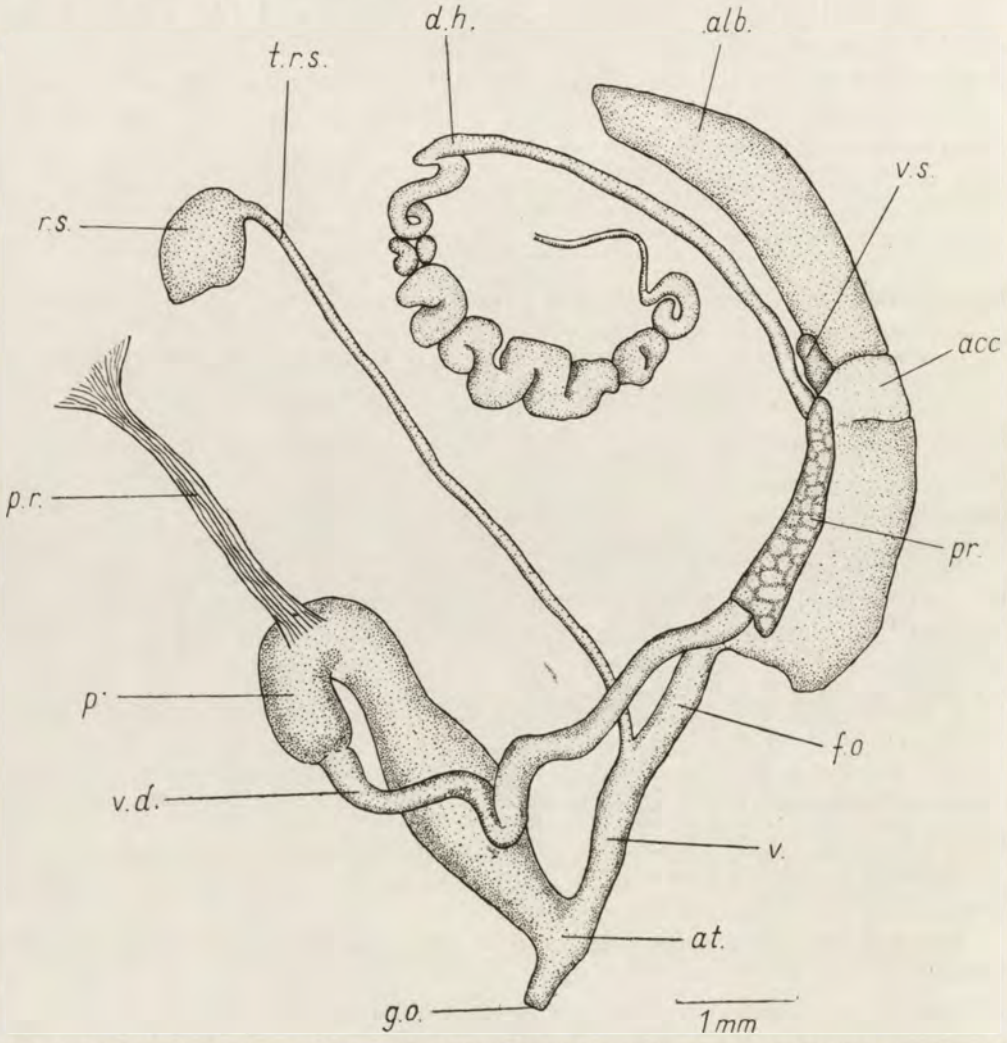


Fig. 1. *Discus* (*Gonyodiscus*) *rotundatus* (Müll.), Poland, Szczecin, 1956, leg. A. Riedel. Genitalia (f. o. — free oviduct, for other explanations see plate III).

The investigation of the inner structure of the genital organs by mounting them in canada balsam proved very fruitful while studying many *Stylommatophore* groups. Here it failed. I have not been able to discover any further differences between the species of the subgenus *Discus* s. str. and those of *Gonyodiscus* Fitz., using that method.

In the light of these anatomical traits, the characters used so far for setting up the infrageneric taxonomy of *Discus* Fitz. gain a new sense. The red-brownish shell-marking stressed by Geyer (1927), Lindholm (1927), Thiele (1931) and others is typical for the subgenus *Gonyodiscus* Fitz. A unicolorous horny yellow-brownish shell is typical for the subgenus *Discus* s. str. The analysis of the geographical distribution by Lindholm (1927) provides some additional confirmation of my taxonomical arrangement. So we have the subgenus *Discus* s. str. of Holarctic distribution and the subgenus *Gonyodiscus* Fitz. of European distribution[1].

In this paper I shall not consider in detail the following forms (assigned erroneously by Westerlund, 1889 and some other writers to the genus *Patula* Held, and to the groups *Discus* Fitz. and *Gonyodiscus* Fitz.):

Helix balmei Potiez et Michaud, 1838
Helix balmei var. *erdeli* Roth, 1855
Helix sudensis Pfeiffer, 1846
Helix sudensis var. *cypria* Kobelt et Rolle, 1897.

All these forms were separated by Wenz (1919) from the genus *Gonyodiscus* Fitz. into the genus *Pleurodiscus* Wenz. Watson (1920) demonstrated convincingly that this whole group has nothing at all to do either with the genus *Gonyodiscus* Fitz. or even with the family *Endodontidae*. *Pleurodiscus* Wenz belongs obviously to the superfamily *Orthurethra*, while the *Endodontidae* belong to the superfamily *Sigmurethra*. My own studies on *Pleurodiscus erdeli* (Roth) from Turkey have fully confirmed Watson's theory. Thiele (1931) created for *Pleurodiscus* Wenz a separate family *Pleurodiscidae*. Boettger (1957) placed *Pleurodiscus* Wenz as the only genus of the subfamily *Pleurodiscinae* in the family *Valloniidae*.

Helix frivaldskyana Rossmässler, 1842

As a result of a detailed anatomical study by Riedel and Urbański (in litt.) it was found that this species should be placed in the family *Zonitidae*.

Helix zapateri Hidalgo, 1870

In the definition of that form (Hidalgo, 1870) we read the following: "Testa... tenuis, pellucida, subnitida...". These characters, as well as the large size of the shell never occur in *Discus* Fitz. On the other hand the shell of *H. zapateri* Hid. lacks the delicate radial costulation, characteristic of *Discus* Fitz. The rest of the definition as well as a good drawing (Hidalgo, 1871, t. 12, fig. 4) indicate clearly enough that this form does not belong to *Discus* Fitz.

Helix carpetana Hidalgo, 1870

In spite of the statement: "*Helici ruderatae* simillima..." it is hard to say, which animal the writer had in mind. There is no drawing and the description is totally insufficient.

[1] The occurrence of *D.* (*G.*) *rotundatus* (Müll.) in Newfoundland, being obviously the result of accidental introduction does not disprove this statement. As to "*Discus* (*Gonyodiscus*) *marmorensis* H. B. Baker" (Baker, 1932; Pilsbry, 1948) its appurtinance to *Gonyodiscus* Fitz. seems to me dubious as based on shell morphology only. Compare Forcart (1957).

However, judging from the definition: "...testa... pellucida, nitidiuscula, subvirescenti--cornea..." I presume, that this is not a species of *Discus* Fitz. in which these characters never occur.

Patula ruderata var. *Gorktschaana* Mousson, 1875

This form was described by Mousson (1875) from the vicinity of the lake Sevan in Armenia (called by Mousson lake Gorktscha), but the original description was rather inaccurate and incomplete. O. Boettger (1881) regarded this form as a separate species, for which he used the name *Patula goctschaana* Mouss. Lindholm (1922) on the basis of two specimens from the collection of O. Retowski, coming from Batumi, U.S.S.R. produced a thorough description of the shell morphology of that species. Riedel (1959) after studying these two shells, now kept in the Zoological Institute of the Polish Academy of Science in Warsaw, assigned this species under the name *Oxychilus ? gorktschaanus* (Mousson) to the family *Zonitidae*. As characters of taxonomical value he took into consideration the spiral striation, very feeble radial striation, the translucence and the delicate glitter of the shell. As these traits never occur in *Discus* Fitz., being typical for the *Zonitidae*, and as this form generally shows a close resemblance to *Oxychilus* (*Oxychilus*) *disciformis* Riedel the resolution of Riedel seems to be right.

Patula spatiosa Lindholm, 1922
Goniodiscus spatiosus (Lindh.) — Likharev & Rammelmeier, 1952

In his description of that species Lindoholm wrote: "Es ist dies der erste kaukasische Vertreter einer bisher von hier unbekannten Gruppe der Gattung *Patula*, deren Verbreitung in den östlichen Mittelmeerländern liegt und zu welcher folgende durch relativ stattliche Grösse ausgezeichneten Arten gehören: *P. erdeli* Roth. ..., *P. sudensis* Pfr. ..., und ihre var. *cypria* Kob. ..., *P. balmei* Pot. et Mich.". The description was based on a single shell from the transcaucasic territories of the Soviet Union. Despite the lack of richer material to enable the anatomical investigation I think the cited opinion is perfectly reasonable. This is indicated by the size and shape of the shell as well as by the localization of the find, not so far east from the eastern boundary of the area occupied by *Pleurodiscus* Wenz. *Patula spatiosa* Linh. should undoubtedly belong to *Pleurodiscidae*, to the group of species resembling *Pleurodiscus balmei* (Potiez & Michaud).

Helix omalisma [Bourgignat] Fagot, 1879

This name should be regarded as synonymous with *Discus* (*G.*) *rotundatus* (Müll.). Fagot claimed in the original description that this species belonged to one group with "*H. rotundata* Müll." and "*H. abietina* Bgt.". Thus he was aware of the close resemblance of these forms. Bofill & Haas (1920) at first (p. 72) took "*Pyramidula* (*Gonyodiscus*) *rotundata omalisma* Bgt." for a subspecies of *D. rotundatus* (Müll.). But next (p. 1107) they described a population from Banyoles, south-eastern Pyrenees, consisting of specimens of "*P. rotundata omalisma* Bgt." and "*P. rotundata rotundata* Müll." and of intermediate specimens. These last ones formed a complete series, joining the two extremal "subspecies". On the ground of that observation the authors came to the conclusion that "*P. rotundata omalisma* Bgt." was synonymous with "*P. rotundata* Müll.". That opinion was shared also by Germain (1930).

TECHNICAL REMARKS

In counting the number of whorls I followed the method used by Ehrmann (1927). The measurements of the diameter of the shell and of the umbilicus were taken using the standard technique. The height of the shell was measured by the method applied by Riedel

(1957, p. 337). As abbreviations I use "altitudo paralella" for the height, measured with a vertical position of the shell-axis, "altitudo obliqua" for the height, measured with an oblique position of the shell-axis.

SYSTEMATIC TREATMENT

Discus (Discus) ruderatus ruderatus (Hartmann, 1821)

For synonymes see Kennard & Woodward, 1926, p. 156.

Material. Shells: Sweden, coll. O. Retowski — 8 specimens; Lappland — 31 specimens; Finnland, Ösel Isl. (Saaremaa), Ticka — 3 specimens; Dorpat — 3 specimens; Lower Austria, Hochwechsel, coll. A. J. Wagner — 12 specimens; Switzerland — 10 specimens; Rumania: Cibin Mts., coll. A. J. Wagner, 2 samples — 19 specimens; Riu Satului, coll. A. J. Wagner — 5 specimens; U.S.S.R.: Minsk, coll. K. Jelski — 24 specimens; Crimea, coll. O. Retowski, 4 samples — 66 specimens; Crimea, coll. A. J. Wagner — 3 specimens; Soviet Armenia, Garni by Yerevan, leg. A. Riedel — 2 specimens; Soviet Armenia, Stepanavan, leg. Shelkovnikov — 3 specimens; Poland, numerous specimens — 71 samples from the whole country. Soft parts: Poland, numerous specimens — 33 samples from the whole country; U.S.S.R.: Caucasus, leg. R. Wojtusiak — 1 specimen; North Caucasus, Zheleznovodsk by Piatigorsk, leg. I. M. Likharev — 2 specimens; Soviet Armenia; distr. Stepanavan, Gerger, leg. N. N. Akramovski — 1 specimen; distr. Archangel, Ust-Cylma, leg. Zhuravski — 4 specimens.

Shell. The dimensions of Polish specimens range mostly from diameter major 5 mm, altitudo paralella 2,5 mm and $3\frac{3}{4}$ whorls to diameter major 6,2 mm, altitudo paralella 3,3 mm and 4 whorls. The vast majority of the shells coming from Europe does not exceed these limits. I know only of several specimens from Poland exceeding 7 mm in diameter. Of particular interest are the samples from Crimea, especially those from the Kosma-Damian monastery, and from Asamatt, in which the diameter major varies between 6,5 mm and 7 mm. Dimensions of the biggest specimens known to me are presented on table 1. The height to diameter ratio is markedly variable. The depth of the sutures and the convexity of the whorls also display a remarkable variability.

Another very interesting sample comes from Karkonosze Mts. in Poland. It is labelled "Kleine Schneegrube im Riesengebirge", and comes perhaps from the collection of R. Jetschin. These shells are big and differ from all others in that they have very high spires, deep sutures and more convex whorls. The last whorl has a slight tendency for scalarity [Pl. IV, Fig. 13]. The dimensions of three specimens, differing mostly from the typical *D. ruderatus* (Hartm.) are shown in table 1. The remaining six are not so high. These are, however, younger. Three of them count $4\frac{1}{2}$ whorls, the other three $4\frac{1}{4}$ whorls. As to the height of the shell the last whorl adds very much, these specimens, being fully grown, would be perhaps as high as those figured in table 1. It is curious enough that shells of these animals are almost identical with the shells obtained by Boettger (1929, Figs. 12 — 13) by breeding the typical *D. ruderatus* (Hartm.) from Germany under hot-house conditions. It is therefore a form of *D. rude-*

ratus (HARTM.) resembling the forma *abietina* (BGT.) of *D. rotundatus* (MÜLL.) (compare p. 321). As to the factors causing the formation of that extremely interesting scalaric form I suppose that the influence of warm springs, common in that territory must be involved. Such warm springs may produce conditions similar to those of a hot-house. A situation of that kind was described by ANKERT (1917) from Lovosice upon the Elbe in Bohemia. In a deep rocky crevasse, with a warm spring on the bottom of it, he found several species of snails active during the whole winter-season. He also found out that while the temperature in open air was of −5° or −10° centigrade, it was still +12° to +14° centigrade inside the crevasse. Unfortunately, only *D. rotundatus* (MÜLL.) occurred there. ANKERT did not state, whether he observed any shel modification in that species.

Table 1

Discus (*Discus*) *ruderatus ruderatus* (HARTM.)

The origin of the examined material	No.	No. of whorls	Shell dimensions in mm					Altitudo paralella to diameter major ratio	Diameter umbilici to diameter major ratio
			Diameter major	Diameter minor	Altitudo paralella	Altitudo obliqua	Diameter umbilici		
Poland, Limanowa, 1923, leg. POLIŃSKI	—	4 1/2	6,8	6,2	3,3	3,0	2,0	0,49	0,29
Poland, Białystok, 1924, leg. JANKOWSKI	—	4 3/4	7,2	6,7	4,1	3,6	2,0	0,57	0,28
Poland, Tatra Mts., Strążyska valley 1955, leg. KOCÓWNA	—	4 3/4	7,7	7,2	4,2	3,7	2,6	0,54	0,34
Crimea, Kosma-Damian monastery, coll. RETOWSKI	1	4 3/4	7,2	6,9	4,1	3,6	2,3	0,57	0,32
	2	4 3/4	7,1	6,6	3,8	3,2	2,1	0,54	0,30
Crimea, Asamatt, coll. RETOWSKI	1	4 3/4	7,4	7,0	4,0	3,6	2,2	0,54	0,30
	2	4 3/4	7,0	6,2	3,4	3,1	2,2	0,49	0,31
Poland, Karkonosze Mts., (coll. JETSCHIN?), the "scalaric" form	1	4 3/4	6,8	6,2	4,3	4,0	1,8	0,63	0,26
	2	4 3/4	6,8	6,4	4,1	3,6	1,7	0,60	0,25
	3	4 3/4	6,9	6,3	3,9	3,4	2,2	0,57	0,32

In the light of the great variability of *D. ruderatus* (HARTM.) it seems doubtful if the Nearctic *Discus cronkhitei* (NEWCOMB) can be regarded as specifically different. Very significant is the following opinion of DALL (1905, fide PILSBRY, 1948): "I am obliged to confess that I am not able to distinguish shells long dead from those of *P. ruderata*... But when the animals are living *P. ruderata*

shows trough the translucent shell deep red or red-brown radiating maculations, which are situated on the mantle. After the shells have been dead some time this maculation disappears. Now the living *P. cronkhitei* do not show any such colour-markings". On the other hand it is well known of that group, that small colour differences are of very little taxonomical value, rather insufficient for distinguishing one species from another. The drawing of the holotype shell of *Discus cronkhitei* (Newcomb) (Pilsbry, 1948, Fig. 328 a, b) does not show any perceivable differences between it and *D. ruderatus* (Hartm.). Shells of *D. cronkhitei* (Newc.) kept in the Zoological Institute of the Polish Academy of Science in Warsaw (6 samples, 33 specimens from Ohio, Ontario, Oregon and Pennsylvania) are in my opinion undistinguishable from those of *D. ruderatus* (Hartm.). I have no knowledge of any paper, containing description or drawings of the genitals of *D. cronkhitei* (Newc.). Studies of that kind could only solve the question whether we are dealing with one Holarctic species only, or with two different, but conchologically undistinguishable species.

Genitalia. The penis (see also description on p. 301 and Pl. III, Figs. 1, 2) is usually smooth, without folds, depressions or swellings. The distal end joined by vas deferens and by penial retractor is the only part which may be thickened so that it can form a kind of a rounded knob.

The prostata (see also description on p. 301 and Pl. III, Fig. 7) is long, narrow, consisting of little folds, lined by little furrows. These furrows are filled with thin, black pigmented fibrillae. The vagina and the free oviduct of the same length, both short. The oviduct thick and remarkably folded.

In all forms of the genus *Discus* Fitz. one more glandular mass is placed between the spermoviduct and the albuminal gland. While the spermoviduct as well as the albuminal gland are greyish in colour and lobular in structure this gland is quite smooth and much lighter. Sometimes it is completely white. Further studies are needed to reveal the structure and function of that organ. At present I call it provisionally the accessoric gland — glandula accessoria. This gland in *D. ruderatus* (Hartm.) is big and well distinguishable.

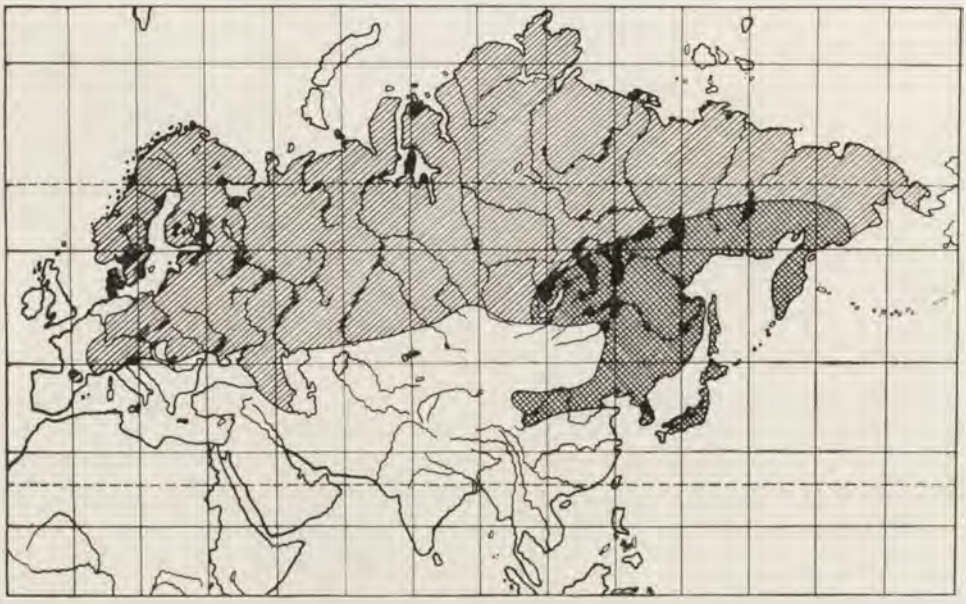
The course of the truncus receptaculi seminis will be explained on p. 311. The receptaculum seminis is oval, remarkably flattened.

The vesiculae seminales are two in number, visible only after mounting the genitalia in canada balsam. Otherwise they look like one, club-shaped, diverticulum.

The distribution [Map 1] of *D. ruderatus* (Hartm.) is Palearctic, or Holarctic if *D. cronkhitei* (Newc.) would be regarded as identical with it.

As an animal typical for the taiga zone in a continental climate it reached its maximum range during the postglacial boreal period. At that time it occurred all over Europe, including the British Isles, where it is now found as a fossil or subfossil only. As the climate grew warmer the animal moved eastwards and up the mountains. In western Europe it is now known exclusively in mountainous regions.

An isolated group of populations occurs in the Pyrenees (Haas, 1925). In France it is completely absent in the lowlands inhabiting only elevated regions from approximately 700 to 2000 metres above sea level, in the departments Jura, Ain, Savoie, Haut-Savoie, and Basses-Alps. It is common all over the Alps. In Germany also mainly in the mountains. The western boun-



Map 1. Geographical distribution of *Discus* (*Discus*) *ruderatus* (Hartm.).
D. (*D.*) *ruderatus ruderatus* (Hartm.),
D. (*D.*) *ruderatus pauper* (Gould).

dary runs along Rhine, the northern one through Nassau and the Harz Mts. In Brandenburg we see it occurring for the first time in lowland. In Italy it is known from Piemonte and Lombardy. The find reported from Sicily (Porro, fide Taylor, 1909) seems to be unreliable, perhaps due to some mistake.

Farther east, due to the more continental climate the area of *D. ruderatus* (Hartm.) is continuous, including mountains as well as lower situated regions. In Austria and Czechoslovakia it is common all over the country, possibly because of the mountainous character of these lands. Its area surrounds the Great Plain of Hungary but without covering it (compare J. Wagner, 1935, 1937, H. Wagner, 1931) and covers the Transylvania and the Transylvanian Alps. In Poland it is found in the whole country, but distinctly more common and more numerous in the mountains and in the north-eastern regions. Common in Denmark, in the Baltic Sea islands, in Scandinavia and in Finland up to the coast of the Barents Sea.

In the Soviet Union nearly all over the country. In the north it reaches the coasts of the Arctic Ocean. In the south it crosses the Caucasus, stretching down to the northern Iran. In Siberia the southern boundary is not very well known. It runs perhaps parallel east from the northern end of the Caspian Sea (Taylor, 1909). The animal probably lives also on the northern slopes of the Altai and of the Sayany Mountains. The form transitional to the subsp. *pauper* (Gould) is abundant around the Lake Baical, known also in Kamchatka, Komandorskiye Islands, Kuril Islands and Korea. Probably it occurs also in Sakhalin and on the coasts of the Sea of Okhotsk.

Discus (Discus) ruderatus pauper (Gould, 1853)

Helix pauper Gould, 1858: 423.
Helix (Patula) elatior A. Adams, 1868: 8.
Helix (Patula) depressa A. Adams, 1868: 9.
Helix bianconii Deshayes, 1870: 23.
Patula ruderata var. *opulens* Westerlund, 1885.
Patula costulata Möllendorff, 1887: 11, 12, t. 2, fig. 2 a–d.
Patula ruderata var. *angulosa* Mousson, 1887: 13, t. 1, fig. 1.
Helix (Patula) potanini Möllendorff, 1899: 55, t. 2, fig. 6.

Material. Shells: no label, probably ex coll. B. Dybowski — 5 specimens; Bering Island, leg. B. Dybowski — 9 specimens; Bering Island, leg. G. E. B. Hamilton — 2 specimens (B. M. N. H.); Japan: Yeso Island — 1 specimen; ex coll. Cuming — 2 specimens (B. M. N. H.); Kumida near Hakodadi, Oct. 1865 — 8 specimens (B. M. N. H.); Kachijojima, Issu — 2 specimens (B. M. N. H.); Chiusiuji, leg. Thomson — 4 specimens (B. M. N. H.); Korea, Onpho near Chongjin, leg. J. Prószyński et B. Pisarski — 4 specimens; China, NW of Pekin — 3 specimens (B. M. N. H.); U.S.S.R.: Vladivostok, 1917, leg. Zaborski — 12 specimens; Amur, leg. B. Dybowski, 3 samples — 63 specimens; Siberia, Kudia river, 1923, leg. Cockerell — 6 specimens (B. M. N. H.). Soft parts: South Kuril Is., Sikotan, leg. Strelkov — 4 specimens; Korea, Onpho near Chongjin, leg. J. Prószyński et B. Pisarski — 5 specimens; the Suputinskij reservation near Vladivostok, leg. I. M. Likharev — 6 specimens; Port Baical on the lake Baical, leg. B. Pisarski — 96 specimens.

Taxonomy. The form in question shows an extreme conchological variability. The height of the spire as well as the keeling of the body-whorl or even the microsculpture of the shell surface vary considerably. Individual specimens often differ so much from one another, that they were on many occasions taken for and described as separate species or subspecies as follows.

Helix pauper Gould, 1858 was described from Petropavlovsk in Kamchatka and from Hakodate in the Yeso Island, Japan on the basis of specimens remarkably depressed and keeled. Westerlund (1889) reported its presence in the Bering Island, Möllendorff (1885) on the shores of Amur and in northern China, Dybowski (1903) in the neighbourhood of the Lake Baical, Ehrmann (1927) in Japan esp. Hakodate.

Helix (Patula) elatior A. Adams, 1868 was described from the Dagelet Island in the Sea of Japan on the basis of specimens "... with the whorls flat, the last acutely keeled and with the sutures margined.".

Helix (*Patula*) *depressa* A. Adams, 1868 was described from the Vladimir-Bay (about 350 km NW of Vladivostok) and from the Yeso Island on the basis of specimens with flattened whorls "... and with the last whorl acutely angulated at the periphery.".

Helix bianconii Deshayes, 1870 was described from "Moupin, Thibet Oriental" on the basis of specimens, which, according to the description and the rather good drawings were very similar to *Discus* (*D.*) *ruderatus ruderatus* (Hartm.).

Patula ruderata var. *opulens* Westerlund, 1885 was described from Bering Island on the basis of specimens with more elevated spire.

Patula costulata Möllendorff, 1887 was described on the basis of a single juvenile specimen from North Korea. That shell was strongly flattened and keeled. Another valuable character was the obtuse but distinct angulation of the edge of umbilicus.

Patula ruderata var. *angulosa* Mousson, 1887 was described from Khabarovka, Permskoje and Vladivostok on the basis of specimens with a rather elevated spire and a light angulation of the last whorl. Afterwards it was reported by Ehrmann (1927) from the village Krasnaja Riechka at the junction of the Ussuri River and the Amur.

Helix (*Patula*) *potanini* Möllendorff, 1899 was described from northern China, Nan-Shan Mountains, prov. Kansu on the basis of big specimens (diam. maj. 8,5 mm, alt. 4,5 mm) with a relatively high spire, relatively deep sutures and a slight keeling of the last whorl.

All the above mentioned descriptions were based only on shell morphology. No anatomical studies were made. Nevertheless many writers pointed out the big difficulties involved in distinguishing these "species" or even doubted their taxonomical status as separate species. For instance Kobelt (1879) stressed the resemblance between "*Helix pauper* Gould" and "*Helix ruderata* Stud." and suggested that they may, in fact, constitute subspecies of one species only. He has noted also the great likeness between "*Helix depressa* A. Adams" and "*Helix pauper* Gould".

My studies have led me to the belief that within the range of forms regarded here as *Discus* (*D.*) *ruderatus pauper* (Gould) there exists a considerable degree of individual variability. It must be strongly emphasized that individuals found in a single locality (and hence drawn probably from a single breeding population) often differ from one another much more that individuals coming from several localities separated by great distances (and hence coming most certainly from different breeding populations).

There is only one clearly visible tendency. Individuals deviating most in their shell-form from the typical *Discus* (*D.*) *ruderatus ruderatus* (Hartm.) come from the basin of Amur. They are more flattened, sometimes almost lenticular, with the last whorl acutely keeled. The keel may be even underlined by shallow furrows running both above and under it. Such specimens form

the sample from Vladivostok, the three samples labelled "Amur" and the sample with no label.

The shells coming from the islands and from Korea resemble more *D.* (*D.*) *ruderatus ruderatus* (Hartm.). They differ only in that they are of bigger size and exhibit a slight angulation of the last whorl. Of that kind are for instance the shells from the Bering Island, Yeso and Sikotan Islands and the cited "var. *opulens* Westld."

It is, however, hard to draw from these data any definite conclusions. For example the sample from the Suputinskij reservation contains beside four specimens of the "Amur type", two specimens of the "island type". In the sample of 5 shells, collected by B. Dybowski and labelled "Amur" the shell No. 1 has a depressed spire, flattened whorls, shallow sutures, acute keel on the last whorl and relatively smooth shell surface. In shell No. 2 the spire is high, the whorls are convex, the sutures deep and the surface distinctly ribbed. Shell No. 4 represents the "island type". Shell No. 3 has all its characters transitional between the specimens No. 2 and No. 4. The juvenile fifth specimen resembles closely the description and drawings of "*Patula costulata* Mlldff." [see Pl. IV, Figs. 14 — 17]. A similar degree of individual variability can also be seen in the samples from the vicinity of the Lake Baical. Apart from the specimens of *D.* (*D.*) *ruderatus ruderatus* (Hartm.) I found there shells of the type of "*Patula ruderata* var. *angulosa* Mouss.". These two forms are connected by a complete series of shells having clearly transitional characters. Another example of high individual variability within one single sample was described by Ehrmann (1927).

While studying the genitals of animals from the neighbourhood of Vladivostok, from the Sikotan Island and from the vicinity of lake Baical I have observed their great similarity to those of *D.* (*D.*) *ruderatus ruderatus* (Hartm.) [see Pl. III, Figs. 3, 4, 8].

Different is the course of the truncus receptaculi seminis. In *D.* (*D.*) *ruderatus ruderatus* (Hartm.) proximally it runs parallel to the spermoviduct on the inner side of its curvature. Near the accessoric gland the truncus receptaculi turns at an obtuse angle, crosses the spermoviduct, turns again and runs parallel to it along the outer side of its curvature. In *D.* (*D.*) *ruderatus pauper* (Gould) the part of truncus receptaculi, crossing the spermoviduct, cuts in between the spermoviduct and the accessoric gland as deep as to be completely hided. In fact in most cases it penetrates between the two organs so deeply that it reaches a point at about three — fourth of their thickness.

Unfortunately even this difference does not enable any final division of the groups in question. For instance animals No. 1, 3, 4 and 5 from the Suputinskij reservation have the truncus receptaculi corresponding with the description given above for *D.* (*D.*) *ruderatus pauper* (Gould). Animal No. 6 from the Suputinskij reservation, animal No. 2 from Sikotan Island and the animals from Lake Baical represent instead the conditions typical for *D.* (*D.*) *ruderatus*

ruderatus (HARTM.). Finally, animal No. 2. from the Suputinskij reservation was of transitional character.

In *D.* (*D.*) *ruderatus ruderatus* (HARTM.) in Poland the course of the truncus receptaculi is typical for that subspecies. Nevertheless in two specimens, one from the Gorce Mts. and one from the Babia Mt. I have found a form transitional between the two subspecies of *D.* (*D.*) *ruderatus* (HARTM.).

Table 2

Discus (*Discus*) *ruderatus pauper* (GOULD)

The origin of the examined material	No.	No. of whorls	Shell dimensions in mm					Altitudo paralella to diameter major ratio	Diameter umbilici to diameter major ratio
			Diameter major	Diameter minor	Altitudo paralella	Altitudo obliqua	Diameter umbilici		
Siberia, Kudia River by Irkutsk, 1923, leg. COCKERELL, B. M. N. H.	—	4 1/3	6,4	5,9	3,0	2,7	2,4	0,47	0,38
	1	4 7/8	7,0	6,8	3,8	3,4	2,4	0,54	0,34
	2	4 1/2	7,0	6,5	3,2	2,8	2,2	0,46	0,31
Amur, leg. DYBOWSKI	3	4 1/2	6,5	6,1	3,6	3,2	2,0	0,55	0,31
	4	4	6,0	5,5	2,7	2,3	1,7	0,45	0,28
Suputinskij res. by Vladivostok, leg. LIKHAREV	1	4 3/4	6,4	6,1	3,1	2,8	2,3	0,48	0,36
	1	4 1/2	7,9	7,5	4,4	3,8	2,7	0,56	0,34
Japan, Chiusiuji, leg. THOMSON, B. M. N. H.	2	4 1/2	7,5	7,1	3,9	3,6	2,5	0,52	0,33
	3	4 1/3	7,6	6,9	3,6	3,4	2,4	0,47	0,32
	4	4 1/4	7,6	6,7	3,4	3,1	2,5	0,45	0,33
Bering Island, leg. HAMILTON, B. M. N. H.	—	4 1/4	6,3	5,8	3,2	2,9	2,1	0,51	0,33
WN of Pekin, leg. MÖLLENDORFF, B. M. N. H.	1	4 1/2	7,3	6,7	3,4	3,1	2,7	0,47	0,37
	2	4 1/2	6,8	6,2	3,3	3,1	2,2	0,49	0,32

I have also noticed some slight differences in the form of the prostata. In animals No. 1, 2 and 3 from the Suputinskij reservation the prostate is nearly twice as broad as it is typical for *D.* (*D.*) *ruderatus ruderatus* (HARTM.). Especially at the distal end, touching the albuminal gland, the prostata broadens still more so that it takes the shape of a very elongated triangle. But the remaining specimens from that locality and the animals from Lake Baical either do not differ in the form of the prostata from *D.* (*D.*) *ruderatus ruderatus* (HARTM.) or have a prostata of transitional form.

Obviously neither conchological nor anatomical characters are sufficient to draw a sharp demarkation line between *D.* (*D.*) *ruderatus ruderatus* (Hartm.) and the Far East forms of the subgenus *Discus* s. str. From all the above given data I conclude the following:

1. all Far East forms of the subgenus *Discus* s. str. should be regarded as a single taxonomical unit,

2. this unit to the best of my knowledge should be named *Discus* (*Discus*) *ruderatus pauper* (Gould).

Shell. The shell shows a considerable range of individual variability as it was discussed above. The biggest specimens come from Japan and measure up to 8 mm or even more (Ehrmann, 1927). Very big was also the "*Helix* (*P.*) *potanini* Mlldff.". The dimensions of some of the examined shells are figured in table 2.

Genitalia. The genitalia are similar to those of *Discus* (*D.*) *ruderatus ruderatus* (Hartm.), but also variable within a considerable range. For details see p. 311 and Pl. III, Figs. 3, 4, 8.

Distribution [Map 1]. The most typical form is known from the basin of Amur. The more or less transitional forms were found in Kamchatka, Kuril Islands, Japan, Korea, northern China and in the vicinity of Lake Baical. Out of the papers of Deshayes (1870) and of Möllendorff (1899) it seems probable that this animal extends farther westwards along the Middle Asian mountainous regions possibly as far as Caucasus. Thus its range seems to have an annular shape, surrounding the steppe and desert territories of Central Asia.

Discus (*Gonyodiscus*) *perspectivus* (Megerle von Mühlfeld, 1814)

Helix perspectiva Megerle von Mühlfeld, 1814: 11, t. 2, fig. 19 a, b. Non *Helix perspectiva* Say, 1817: 256.
Helix solaria Menke, 1830: 19.

Material. Shells: Austria: Salzburg, Lower Austria, Styria, Carinthia, 8 samples — 106 specimens; Poland, numerous specimens (34 samples), from the Sudety, Beskidy and Bieszczady Mts.; Rumania: Transylvania, coll. A. J. Wagner, 2 samples — 42 specimens; Transylvanian Alps, 2 samples — 13 specimens; Yugoslavia, 7 samples — 41 specimens. Soft parts: Trieste, leg. A. J. Wagner — 5 specimens; Styria, leg. A. J. Wagner — 6 specimens; Karawanken, leg. W. Poliński — 1 specimen; Poland, 12 samples — 72 specimens from the Sudety, Beskidy and Bieszczady Mountains.

Shell. The last whorl is always acutely keeled. The height of the spire is very variable. There is a slight tendency of building higher shells in the southern regions. This is in agreement with similar phenomena in the other species of the genus *Discus* Fitz. (compare p. 305 and p. 321). But because of the great individual variability in shell-form it is impossible to regard this tendency as a rule.

In Poland and in Austria the variability range is similar: we can find in a single sample specimens completely flat beside specimens with a high spire.

Shells from Rumania are on the average even more flattened than those from Poland or Austria. Only the shells from Yugoslavia prove distinctly more elevated. Extreme examples may suit the samples from Croatia [Ogulin, coll. A. J. WAGNER, Pl. IV, Fig. 19] and from Sudety Mts., Poland [Bardo Śląskie, leg. A. WIKTOR, Pl. IV, Fig. 20, 21]. For their dimensions see table 3.

Table 3

Discus (*Gonyodiscus*) *perspectivus* (Meg. v. MÜHLF.)

The origin of the examined material	No.	No. of whorls	Shell dimensions in mm					Altitudo parallella to diameter major ratio	Diameter umbilici to diameter major ratio
			Diameter major	Diameter minor	Altitudo paralella	Altitudo obliqua	Diameter umbilici		
Croatia, Ogulin, coll. WAGNER	1	6¼	6,3	5,8	2,7	2,4	2,3	0,43	0,37
	2	6⅛	6,3	6,0	2,8	2,4	2,5	0,44	0,40
	3	6	6,1	5,9	2,5	2,2	2,5	0,41	0,41
	4	6	5,7	5,5	2,5	2,3	2,2	0,44	0,39
	5	5½	5,0	4,8	2,3	2,1	1,9	0,46	0,38
Poland, Sudety Mts., Bardo Śl., leg. WIKTOR	1	5⅝	6,1	5,8	1,6	1,5	2,9	0,26	0,48
	2	5½	5,8	5,3	1,5	1,4	2,7	0,26	0,47
	3	5½	5,6	5,2	1,5	1,5	2,4	0,27	0,43

Many specimens of that species display irregularities in the shell-form. I know some shells from the Sudety Mts., Poland completely flat and slightly bent as a whole [Pl. IV, Fig. 21]. Irregularities in the form of the last whorl are frequent in the samples coming from Austria, especially in well grown specimens. The last whorl may show a slight scalarity in form. Often it is poorly joined with the rest of the shell. It may be wound under the preceding whorl, causing an increase of the height of the shell. Or does it lie on the same level as the remaining whorls but is as little joined with them as to increase visibly the shell-diameter. Sometimes, though rather unfrequently it can be wound up, joining the upper surface of the preceding whorl. Nevertheless all these forms are easily and without any doubt determinable as *Discus* (*G.*) *perspectivus* (Meg. v. MÜHLF.).

Genitalia. The penis is principally cylindrical. Usually it is contracted, twisted and folded making the recognition of its original form difficult. The junction of penial retractor lies more distally than in *D.* (*G.*) *rotundatus* (MÜLL.). The ratio of the length of the distal part (from the penial retractor junction to the vas deferens orifice) to the length of the proximal part (from penial retractor to genital atrium) varies from 1 : 2 to 1 : 4,5, the average being 1 : 3,5. At the place of penial retractors junction the penis is bent sharply at an acute

angle. This bend in *D.* (*G.*) *rotundatus* (Müll.) forms a regular and comparatively wide arch [see Pl. III, Figs. 5, 6]. The penis is more elongated than in *D. rotundatus* (Müll.). The ratio of diameter to length ranges from 1 : 7 to 1 : 11, being 1 : 9 on the average.

The vas deferens, prostate, hermaphroditic gland and the seminal vesicles are similar to those of *D. rotundatus* (Müll.). The albuminal gland and the accessoric gland are comparatively bigger, than in the mentioned species. The oviduct is folded. The free oviduct usually twice as long as the vagina. In about

Map. 2. Geographical distribution of *Discus* (*Gonyodiscus*) *perspectivus* (Meg. v. Mühlf.)
+ The find locality on the Tremiti Isles.

twenty five percent of the specimens examined I have found a very interesting course of the truncus receptaculi. It runs from its orifice distal along the left side of the spermoviduct (opposite the prostata). Then it passes between the hermaphroditic duct and the albuminal gland in the very corner formed by these two organs onto the other side (overlaid by the prostata) of the spermoviduct. On this side it runs back in the proximal direction. That backward directed part is half as long as the receptaculum seminis. Then the truncus receptaculi turns again in the distal direction, reaches the first bend and here it ends in the proximal part of the receptaculum seminis.

Distribution [Map 2]. *Discus* (*Gonyodiscus*) *perspectivus* (Meg. v. Mühlf.) is a Carpathian and East-Alpine species. It inhabits mountainous regions of

moderate elevation above sea level, omitting high mountains as well as lowlands found within its area. E. g. the animal is not found in the Great Plain of Hungary and in the Tatra Mts. although its area of distribution surrounds these territories. It occurs all over Austria, reaching its western boundary in Immenstadt am Alpsee. The northern boundary runs eastwards through Allgäuer Alps, Upper Bavaria, Fichtelgebirge, Bohemian Forest, Erzgebirge and the Sudety Mts. Known from the whole Bohemia and Moravia. An isolated group of populations is found living in the Sobótka Mt., Poland (40 km SW of Wrocław). Eastwards *D. perspectivus* (Meg. v. Mühlf.) inhabits the Carpathians, with the exception of the Tatras. It reaches as far north as Ojców (20 km NNW of Kraków). It is common along the whole Carpathian range down to the Transylvanian Alps and to Transylvania. The southern boundary runs across Serbia and Montenegro to meet the Adriatic coast in the Southern Dalmatia (Kotor). The occurrence of this animal in the Tremiti Islands, Italy is questionable. Shells only were found there on the seashore (Cecconi, 1908). It seems likely that they have been brought there by the sea from the Dalmatian coast. From the northern Dalmatia to Austria the boundary runs trough Karst, Karawanken and Julijske Alpe.

Discus (*Gonyodiscus*) *rotundatus* (O. F. Müller, 1774)

For synonymes see Kennard & Woodward, 1926, p. 154, 156.

Material. Shells: Azores, Fayal, Horta, leg. St. Feliksiak et W. Roszkowski — 14 specimens; France, north-eastern regions, various localities — 26 specimens; France, Avignon, coll. A. J. Wagner — 12 specimens; Germany (Württemberg, Bavaria, Thuringia and Ukermark) — 24 specimens; Switzerland — 1 specimen; Austria: Tirol — 5 specimens; Carinthia — 63 specimens; Styria — 9 specimens; Lower Austria — 43 specimens; Czechoslovakia — 11 specimens; Poland, numerous specimens — 152 samples from the whole country; Norway, coll. O. Retowski — 3 specimens; Sweden, coll. Hartman — 4 specimens; Ösel Island (Saaremaa), Ticka — 7 specimens. Soft parts: Azores, Fayal, Horta, leg. St. Feliksiak et W. Roszkowski — 152 specimens mixed with the f. *abietina* (Bgt.) and with the intermediate forms; Portugal, Leixões — 1 specimen; Spain, Vigo, leg. Borecki — 1 specimen; France, 7 samples — 11 specimens; Styria, coll. A. J. Wagner — 1 specimen; Poland, numerous specimens — 67 samples from all over the country.

Shell. The shell dimensions vary as follows: diameter 5,8 — 7 mm, height 2,4 — 3 mm, whorl number $5\frac{1}{2}$ — $6\frac{3}{4}$. The biggest specimen in my material comes from Kazimierz on the Vistula, Poland [see table 4 and Pl. IV, Fig. 23]. The height to diameter ratio and the relative width of the umbilicus are higly variable. In the territories where the f. *abietina* (Bgt.) occurs there have been found complete series of animals displaying a gradual transition between that form and the typical *D. rotundatus* (Müll.). The shell coloration is also variable. The horny yellowish-brown colour distinctly reddish-brown spotted is highly characteristic for that species. Yet animals living in caves are much paler, sometimes lacking the reddish spotting completely. Such unicolorous shells are found also in not-underground environments, beside animals with

shells normally coloured. In the collection of the Zoological Institute, Polish Academy of Science in Warsaw such unicolorous shells constitute about ten percent of the total number of *D. rotundatus* (Müll.). Taylor (1909) quotes the opinion of Dumont and Mortillet that in Sabaudia, France occur hybrids and forms transitional between *D.* (*D.*) *ruderatus* (Hartm.) and *D.* (*G.*) *rotundatus* (Müll.). I am convinced that this opinion is erroneous and is based on misdetermination of such unicolorous specimens of *D. rotundatus* (Müll.). As it has been indicated above the morphology of the shell in this species exhibits an extreme degree of individual variability. Moreover this variability is of a continuous nature and particular traits seem to vary independently from one another, so that no sharply defined types can be distinguished. In this connection I regard the distinguishing of the following varieties as completely groundless: var. *turtoni* Fleming, var. *alba* Moquin-Tandon, var. *grisea* Moq.-Tand., var. *olivacea* Moq.-Tand., var. *rufula* Moq.-Tand. [in it subvar. *rufula* s. str., subvar. *obscurata* and subvar. *subrufula* (sic!)], var. *major* Locard, var. *minor* Jeffreys.

Table 4

Discus (*Gonyodiscus*) *rotundatus* (Müll.)

The origin of the examined material	No.	No. of whorls	Shell dimensions in mm					Altitudo paralella to diameter major ratio	Diameter umbilici to diameter major ratio
			Diameter major	Diameter minor	Altitudo paralella	Altitudo obliqua	Diameter umbilici		
Poland, Forest of Białowieża, 1929, leg. Roszkowski	1	5 1/2	5,6	5,2	2,3	2,1	1,9	0,41	0,34
	2	5 1/2	5,4	5,0	2,3	2,0	1,9	0,43	0,35
	3	5 1/2	5,3	5,0	2,2	2,0	1,9	0,42	0,36
Poland, distr. Suwałki, Wigry, 1933, leg. Feliksiak	1	6	6,2	5,8	3,1	2,8	2,0	0,50	0,32
	2	5 3/4	6,3	5,8	2,8	2,5	2,2	0,44	0,35
	3	5 1/2	6,4	5,8	2,4	2,2	2,2	0,38	0,34
Poland, Kazimierz on the Vistula, 1957, leg. Riedel	—	6 7/8	8,1	7 7	3,0	2,8	3,4	0,37	0,42

Genitalia. The penis is cylindrical in form, sometimes thickened and folded here and there. At the insertion of the penial retractor the penis is bent in the shape of a walking stick handle [see Pl. III, Fig. 6]. This bend divides the penis into two parts. The distal part, from the place of junction of the vas deferens to the place of junction of the penial retractor is shorter. The proximal part, from the place of junction of the penial retractor to the proximal end of penis (joining the genital atrium) is longer. The average ratio of the length of these two parts is 1 : 2,5 varying from 1 : 2 to 1 : 3,5. The relative thickness

of the penis is bigger than in *D. perspectivus* (Meg. v. Mühlf.). The diameter to the length ratio is 1 : 6,7 on the average, varying from 1 : 5,5 to 1 : 8.

The vas deferens is more thick than in the *Discus* s. str. The prostate was dealt with on p. 302 [see also Pl. III, Fig. 10]. The colouring of the prostate is rather light, since the pigmented fibrillae are absent. The hermaphroditic duct in its middle is strongly thickened and twisted. The albuminal gland is relatively small and thin. The two vesiculae seminales are twisted one around

Map. 3. Geographical distribution of *Discus* (*Gonyodiscus*) *rotundatus* (Müll.).

▨ Stated area, ▨ Probable area,

\+ Find localities of *D.* (*G.*) *rotundatus* (Müll.) outside, or on the borders of its area,

● Find localities of *D.* (*G.*) *rotundatus* f. *abietina* (Bgt.).

the other and covered by a thick layer of the pigmented fibrillae, sometimes completely black. Their form and shape are visible only in genitals mounted in canada balsam. The accessoric gland is differing in size in different individuals. The oviduct is thick and folded. The position of the orifice of the truncus receptaculi is variable. Therefore the parts called vagina and free oviduct are variable in length. In extremal cases there are found animals with a long vagina, almost without the free oviduct (i. e. with a distal position of the orifice) or with a long free oviduct but almost without the vagina (i. e. with a pro-

ximal position of the orifice). The truncus receptaculi of medium length. The receptaculum seminis is oval and flattened. It lies along the albuminal gland between half its length and its distal end. The genital atrium is short and small.

Distribution [Map 3]. *Discus* (*Gonyodiscus*) *rotundatus* (Müll.) is a middle- and west-european species. In the territories where it occurs beside *D. ruderatus* (Hartm.) an ecological vicarage can be observed. *D. ruderatus* (Hartm.) inhabits the mountainous zones, *D. rotundatus* (Müll.) inhabits territories of milder climate, i. e. lowlands. It was reported by Watson (1876) from Azores and Madeira and from the islands of the Mediterranean (Baleares, Corsica, Sardinia and Sicily). In Algeria occurs exclusively the f. *abietina* (Bgt.)

D. (*G.*) *rotundatus* (Müll.) inhabits Portugal, Spain, Great Brittain, France, Belgium, Netherlands, Germany, Bohemia and Moravia, Switzerland, Austria and Italy. In Norway it ranges as far as the 63° northern latitude. In Sweden it reaches the district of Stockholm. It lives in Denmark and in the islands of the Baltic Sea: Bornholm, Christiansö, Öland and Gottland (Schlesch, 1927a, b, 1934). The south-eastern and eastern boundaries are not well known. Perhaps from the Julijske Alpe, Yugoslavia it runs north-eastwards along the east-alpine foreland, passing by both the Great and the Little Plains of Hungary, and the Balkan peninsula. The animal inhabits Slovakia (Ložek, 1956) yet the eastern boundary is not sufficiently known. In Poland it is common all over the country, but it is decreasing in number eastwards. It is difficult to explain why this animal has not been found in the Bieszczady Mts., Poland, while Bąkowski (1892) reported it from localities situated still farther east. As a result of an oversight Urbański (1947) did not report it from the Plateau of Lublin, Poland where it was found by Poliński (1912). Likharev & Rammelmeier (1952) reported it from the vicinity of Kiev, Ukraine and from the district of Minsk, Byelorussia. Well known is the find in Crimea, reported by Retowski (1883). It is a single shell of the f. *abietina* (Bgt.), now kept in the Zoological Institute, Polish Academy of Science, Warsaw. The single find of *D. rotundatus* (Müll.) in Rumania is rather enigmatical. It was reported from Sibiu, formerly called Hermannstadt, by Kimakowicz (1883). Perhaps it is due to accidental introduction.

As the range of *D. rotundatus* (Müll.) in the East is not limited by any natural barrier it has perhaps no sharply delimited boundary, but it simply gradually decreases in number eastwards. In Lithuania it was reported by Schlesch (1938) from the neighbourhood of Kovno, and by Sivickis (1938, fide Schlesch, 1942) from Taurage and Kratinga. It inhabits the islands Saaremaa and Hiiumaa (Ösel and Dagö, Krausp, 1932). In North America it lives in Newfoundland and in Massachusetts. All Americal populations are completely isolated from one another and have an obviously synantropic distribution. This evidence leads us to the conclusion, that the animal has been brought there by man (Pilsbry, 1948).

Discus (*Gonyodiscus*) *rotundatus* f. *abietina* (Bourguignat, 1864)

Helix abietina Bourguignat, 1864: 179, t. 19, fig. 17 — 19.
Helix (*Patula*) *rotundata* Müll. — Retowski, 1883: 6.
Patula abietina var. *spelaea* Kobelt, 1907, Iconographie, N. F., 13, Nr. 2111.
Gonyodiscus rotundatus f. *pallida* Germain, 1911: 244.
Gonyodiscus rotundatus f. *alta* Germain, 1911: 244, t. 13, fig. 44 — 47.

Material. Shells: Crimea, Theodosia, coll. O. Retowski — 1 specimen; Sardinia, Sorgono, prov. Cagliari — 7 specimens; Sicily, Palermo — 26 specimens; "Höhle von Olevano bei Neapel" — 14 specimens; Spain, Vigo, leg. Borecki — 1 specimen; Spain, Gijon, leg. Sz. Tenenbaum — 1 specimen. Soft parts: Azores, Fayal, Horta, leg. St. Feliksiak et W. Roszkowski — 152 specimens mixed with *D. rotundatus* (Müll.) and with the intermediate forms.

Taxonomy. Under the name of *Helix abietina* there were described by Bourguignat (1864) animals from Algeria, differing from *D. rotundatus* (Müll.) in that they had more elevated spire, deeper sutures, narrower umbilicus and were stronger costulated. They were yellow-brownish in colour, reddish spotted and had the last whorl obtusely angulated as it is in *D. rotundatus* (Müll.). From the "Höhle von Olevano am Tusciano, prov. Salerno" there was described by Kobelt (1907) the *Patula abietina* var. *spelaea*. It had a much paler shell coloration than the typical "*Patula abietina* Bgt.". Germain (1911) described from the "Grotte d'Arudy, dep. Basses Pyrenees", France and from the "Cueva del Collerada, prov. Huesca", Spain two forms of *D. rotundatus* (Müll.). The first one, based on specimens with paler shells he named forma *pallida*, the other one, based on specimens with more elevated spire, he named forma *alta*. He noticed that in the specimens of forma *alta* there was observable a pathological (in his opinion) tendency for scalarity, i. e. for disjoining of the last whorl. He reported also the occurrence of typical *D. rotundatus* (Müll.) mixed with the f. *alta*. The ratio of number of specimens of f. *alta* and *D. rotundatus* (Müll.) was 1 : 1. Boettger (1929) rejected this theory, stating that young specimens of the form involved are more flattened and do not differ much from the typical *D. rotundatus* (Müll.). It is the last whorl that adds most to the height of the shell, making it elevated. Thus the two groups mentioned by Germain were adult and young specimens of the same breeding population.

The problem of forms of *Discus* (*G.*) *rotundatus* (Müll.) was thoroughly studied by Boettger (1929, 1930, 1931, 1939). In his paper in 1929 he described a population of *D. rotundatus* (Müll.) living in the hot-houses of the Botanic Garden in Berlin. This study revealed the morphological identity of these animals with the *Helix abietina* Bgt. and with the *Patula abietina* var. *spelaea* Kob. They were not specimens of *H. abietina* Bgt. introduced there accidentally, since similar populations occurred in other hot-houses, belonging to gardeners who did not keep or exchange any overseas plants, e. g. those coming from Algeria. Had the animal been brought with imported plants it certainly

would have occurred in the Botanic Garden hot-houses only. Hence these snails must have been descendants of the local population of *D. rotundatus* (Müll.), changed by the different environmental conditions.

This conclusion was proved experimentally. Boettger bred the typical, flattened *D. rotundatus* (Müll.) in glass containers under conditions similar to those of a hot-house. In that way he obtained already in the first generation animals with elevated spire, narrow umbilicus and strong costulation of the shell surface, fitting perfectly the description of *H. abietina* Bgt. In many shells a slight scalarity appeared, characteristic for animals coming from caves. The following generations did not change more but were of the same type as the first generation.

Of peculiar interest is the fact, that *Discus* (*D.*) *ruderatus* (Hartm.), kept for comparison in similar conditions behaved almost identically with *D.* (*G.*) *rotundatus* (Müll.). It also produced the first generation provided with a high spire, deep sutures, narrow umbilicus and the last whorl only feebly joined with the preceeding one. That type remained unchanged in the later generations. These animals resembled very closely the scalaric form of *D.* (*D.*) *ruderatus* (Hartm.) from Karkonosze Mts., Poland (see p. 305).

I presume that this illustrates a tendency common to the whole genus *Discus* Fitzinger, a tendency of reacting on some peculiar influences by building a shell of peculiar type, i. e. with higher spire, deeper sutures etc.

Further evidence pertaining to that problem was provided by Boettger (1930). He found that in Berlin the hot-house population and the wild population were isolated from one another and differed sharply in their shell-form. While visiting several botanic gardens in middle and southern Italy he found, that the situation there was entirely different. In these gardens the hot-houses were open during the whole summer-season, and the conditions in open air differed less from those of the hot-house than it was in Berlin. The result was that the two populations intermixed. The hot-house form could be found in the garden, and the wild form in the hot-house, and they differed less in their morphology. In the botanic gardens in Rome, and in Palermo, Sicily the writer found the hot-house form only.

Forms transitional between *D. rotundatus* (Müll.) and the cave form were reported from the caves in Belgium by Boettger (1939). This writer (1929, 1930) demonstrated also the close connection between the shell coloration and the intensity of light in the environment in which the animal is living. E. g. animals living in hot-houses in Rome had much brighter-coloured shells than the animals living in shaded stone heaps a couple of yards away. The shell coloration is by no means hereditary. The albinismus only, occurring very rarely, is inherited as a recessive character. Therefore the shell coloration can not be regarded as a character of any taxonomical value.

As to the factors causing the formation of that hot-house- or cave-modification Boettger presumed that it must be the relatively high humidity, and

the absence of temperatures approximate to or lower than zero centigrade. This is because these are the only factors common to the caves and the hot-houses as well. Next the writer concluded, that in Algeria this animal must occupy rather humid environments.

These last conclusions seem doubtful to me. It is highly improbable, that the form, produced by high humidity, living in a land of a dry climate like Algeria, never turns into the form, caused by a dry environment. And the fact is, that the typical *D. rotundatus* (Müll.) has never been reported from Algeria. I think it wiser to take into consideration the period of hibernation, which causes substantial changes in the whole physiology of the hibernating organism. I presume, that animals that have hibernated build then a flattened shell and those, that have not, build a shell with an elevated spire. May be Boettger (1929) is right, taking this for an adaptation for hiding in small clefts, or lack of such an adaptation. Yet, if this is the case, it is an adaptation for hiding against frost, not against the dry season. This thesis provides a better explanation of the geographical distribution of that form.

Finally, the influence of hibernation, as of a factor acting once and strongly explains better the way, the animals change, while bred experimentally. This explains, why already in the first generation the whole population changed into the f. *abietina* (Bgt.) and in the next generations it remained with no further changes. If it were the influence of high humidity, i. e. of a factor acting continuously and not too strongly, one should expect gradual and more slowly progressing changes. The stabilisation of the final form should take place in some of the later generations.

This problem can be solved by another experiment, viz. by hibernating artificially the hot-house form under the conditions of relatively high humidity. Possibly this would prove, that the species *D. rotundatus* (Müll.) occurs in two forms. These forms would turn one into the other depending on whether this particular population had or had not hibernated. Similar facts are well known in entomology, e. g. the spring and summer generations of *Araschnia levana* L. (*Lepidoptera, Nymphalidae*).

Regardless of the factors causing the changes mentioned above, all the populations from the hot-houses, caves, breeding experiments and from the Mediterranean area should be regarded as one form. The first three act as ecological forms, the last one as a geographical form of *D. rotundatus* (Müll.), but they all should be regarded as *Discus* (*G.*) *rotundatus* f. *abietina* (Bgt.).

Shell. The majority of the shells examined display a remarkable individual variability. The single specimens from Spain and Crimea [Pl. IV, Fig. 24] have the typical characters of the f. *abietina* (Bgt.) strongly expressed, i. e. they have high shells, deep sutures, the umbilicus is much narrower and the ribs of the shell-surface are more prominent than in *D. rotundatus* (Müll.). In the samples from the cave of Olevano near Naples and from Palermo, Sicily [Pl. IV, Figs. 25, 26, table 5] apart from the shells recognizable as *D. rotun-*

datus f. *abietina* (Bgt.) there occur also specimens with shells more flattened. As the height of the shell depends to a great extent on the development and form of the last whorl, the young animals with 4 — 5 whorls are always much more flattened than the fully grown ones. But in these two samples there occur adult shells having $5\frac{1}{2}$ — 6 whorls, and still being in all their characters transitional between *D. rotundatus* (Müll.) and its f. *abietina* (Bgt.). The sample from Sardinia is rather uniform consisting of shells of the transitional type. Most interesting are the samples from Azores. Apart from the shells of the typical *D. rotundatus* f. *abietina* (Bgt.) there are animals with shells undistinguishable from those of *D. rotundatus* (Müll.) coming from Poland. These extreme forms are connected by a complete series of animals of intermediate characters, so that it is impossible to sort one from the other.

Table 5

Discus (*Gonyodiscus*) *rotundatus* f. *abietina* (Bgt.)

The origin of the examined material	No.	No. of whorls	Shell dimensions in mm					Altitudo paralella to diameter major ratio	Diameter umbilici to diameter major ratio
			Diameter major	Diameter minor	Altitudo paralella	Altitudo obliqua	Diameter umbilici		
Crimea, coll. Retowski	—	$5\frac{1}{2}$	5,1	4,8	2,7	2,5	1,6	0,53	0,31
Spain, Gijon, 1926, leg. Tenenbaum	—	$6\frac{1}{4}$	6,1	5,8	3,0	2,8	2,1	0,49	0,34
Italy, the cave of Olevano	1	$5\frac{3}{4}$	6,2	6,0	3,3	3,0	1,8	0,53	0,29
	2	$6\frac{1}{4}$	5,9	5,7	3,2	2,9	2,1	0,54	0,36
	3	6	5,5	5,2	3,0	2,7	1,6	0,55	0,29
Sicily, Palermo	1	$5\frac{3}{4}$	5,4	5,0	2,6	2,4	1,8	0,48	0,33
	2	6	5,0	4,8	2,7	2,4	1,6	0,54	0,32
	3	6	5,6	5,1	2,8	2,5	1,5	0,50	0,27
Azores, Fayal, Horta, slopes of Mt. Queimada, 1932, leg. Roszkowski et Feliksiak	1	$5\frac{3}{4}$	5,9	5,5	3,1	2,7	1,9	0,53	0,32
	2	6	5,7	5,4	3,0	2,7	2,1	0,53	0,37
	3	$5\frac{1}{2}$	5,3	5,1	2,7	2,4	1,8	0,51	0,34
Algeria, coll. Norman (ex coll. Morelet), B. M. N. H.	1	$5\frac{3}{4}$	6,2	5,8	3,1	2,7	2,3	0,50	0,37
	2	$5\frac{3}{4}$	5,9	5,6	2,8	2,6	2,0	0,47	0,34
	3	$5\frac{1}{2}$	5,7	5,2	2,7	2,4	2,1	0,47	0,37

Genitalia as in the typical *D.* (*G.*) *rotundatus* (Müll.). The variability range is also much alike.

Distribution [Map 3]. It occurs in the whole area occupied by *D. rotundatus* (Müll.) wherever the environmental conditions (presumably the lack of hibernation) enable it to arise. Reported by Retowski (1883) from Crimea

as *Helix* (*Patula*) *rotundata* MÜLL. It inhabits the middle and southern Italy and Sicily, partially in hot-houses (BOETTGER, 1930), or in caves (KOBELT, 1907). Shells were reported to be stranded on the Tremiti Islands, Italy (CECCONI, 1908). Found in Sardinia (HESSE, 1927) and Corsica (CAZIOT, 1908). In Berlin-Dahlem in many hot-houses (BOETTGER, 1929). In France in the "Grotte d'Arudy" and in the "Grotte d'Izeste", both in the dep. Basses Alps (BOETTGER, 1931). In Normandy and in Bretagne its occurrence is due perhaps to the influence of the mild, oceanic climate. In Spain in the "Cueva del Collerada, prov. Huesca" (BOETTGER, 1939). In Algeria and the Azores.

CONCLUSIONS

I presume, that the groups *Discus* FITZINGER, *Gonyodiscus* FITZINGER, and *Patula* HELD should be regarded as a single genus, its proper and nomenclatorically valid name being *Discus* FITZINGER.

The following species, erroneously assigned to that genus should be excluded from it: *Helix balmei* POTIEZ & MICHAUD, 1838; *Helix balmei* var. *erdeli* ROTH, 1855; *Helix sudensis* PFEIFFER, 1846; *Helix sudensis* var. *cypria* KOBELT & ROLLE, 1897; *Helix frivaldskyana* ROSSMÄSSLER, 1842; *Helix zapateri* HIDALGO, 1870; *Helix carpetana* HIDALGO, 1870; *Patula ruderata* var. *Gorktschaana* MOUSSON, 1875; *Patula spatiosa* LINDHOLM, 1920.

The genus *Discus* FITZ. displays a remarkable range of individual variability. Therefore, more divergent specimens were on many occasions described as different species or subspecies. Eight out of them are regarded here as synonymous with *Discus* (*D.*) *ruderatus pauper* (GOULD), and four as synonymous with *Discus* (*G.*) *rotundatus* f. *abietina* (BGT.).

All species of the genus *Discus* FITZ. show a tendency towards the building of high shells in a warm climate or microclimate. This is perhaps due to the lack of hibernation.

The anatomy of the genitals implies that this genus should be divided in two subgenera. In *Discus* s. str. the penis is joined terminally by the penial retractor and laterally by the vas deferens. The prostate is narrow, elongated and formed into small folds. In *Gonyodiscus* FITZ. the penis is joined laterally by the penial retractor and terminally by the vas deferens. The prostate is broad, triangular or semicircular in shape and thickly folded.

Discus s. str. has unicolorous, horny yellow-brownish shell and a Palearctic (or Holarctic ?) distribution. *Gonyodiscus* FITZ. has yellow-brownish shell, with reddish, radial spotting and has a european distribution.

The proper taxonomical arrangement of that group was given on p. 301.

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STRESZCZENIE

Autor omawia w pracy morfologię, taksonomię, synonimikę i rozmieszczenie geograficzne palearktycznych ślimaków z rodzaju *Discus* Fitz.

Na podstawie budowy narządów płciowych dzieli rodzaj *Discus* Fitz. na dwa podrodzaje: *Discus* s. str. i *Gonyodiscus* Fitz. U *Discus* s. str. vas deferens uchodzi do penisa lateralnie, zaś retraktor penisa przyczepia się terminalnie. Prostata jest długa, wąska, drobno pofałdowana. U *Gonyodiscus* Fitz. vas deferens stanowi terminalne przedłużenie penisa, a retraktor przyczepia się lateralnie. Prostata jest szeroka, trójkątna lub półkolista, złożona z dużych fałdów. Ponadto *Discus* s. str. charakteryzuje się jednobarwną, żółtawobrunatną muszlą i rozmieszczeniem palearktycznym (lub holarktycznym), *Gonyodiscus* Fitz. ma muszlę dwubarwną, żółtawobrunatną z czerwonawymi plamami i występuje prawie wyłącznie w Europie.

Rodzaj *Discus* Fitz. wykazuje wielką zmienność indywidualną i populacyjną. Wszystkie gatunki rodzaju wykazują między innymi tendencję do budowania wyższej muszli w warunkach ciepłego klimatu lub mikroklimatu, prawdopodobnie na skutek braku okresu zimowania. Zmienność konchiologiczna była powodem opisywania wielu „gatunków" i „podgatunków", które zostały w niniejszej pracy krytycznie omówione.

РЕЗЮМЕ

Автор обсуждает в настоящей работе морфологию, таксономию, синонимику и географическое распространение палеарктических форм моллюсков из рода *Discus* Fitz.

На основании строения половых аппаратов автор разделяет род *Discus* Fitz. на два подрода: *Discus* s. str. и *Gonyodiscus* Fitz. У *Discus* s. str. семепровод переходит в пенис латерально, а ретрактор пениса прикрепленный терминально. Простата длинная, узкая, с мелкими складками. У *Gonyodiscus* Fitz. семепровод составляет терминальное продолжение пениса, а ретрактор прикреплен латерально. Простата широкая, трехугольная или полукруглая, с большими складками. Кроме того *Discus* s. str. характеризируется одноцветно желто-коричневой раковиной и палеарктическим (или голарктическим) размещением, у *Gonyodiscus* Fitz. раковина двуцветная, желто-коричневая с красноватыми пятнами, а его виды встречаются почти исключительно в Европе.

Род *Discus* Fitz. проявляет большую индивидуальную и популяционную изменчивость. Все виды этого рода обнаруживают между прочим стремление к строению более высокой раковины в условиях теплого климата или микроклимата, вероятно вследствие отсутствия периода зимовки. Конхиологическая изменчивость была причиной описания многих „видов" и „подвидов", которые были в настоящей работе критически обсуждены.

Plate III

Genitalia: acc. — accessoric gland, alb. — albuminal gland, at. — atrium, d. h. — ductus hermaphroditicus, g. o. — genital orifice, p. — penis, p. r. — penial retractor, pr. — prostate, r. s. — receptaculum seminis, t. r. s. — truncus receptaculi seminis, v. — vagina, v. d. — vas deferens, v. s. — vesiculae seminales.

Fig. 1. *Discus* (*D.*) *ruderatus ruderatus* (Hartm.). Poland, distr. Grójec, Konary, 1919, leg. W. Roszkowski.

Fig. 2. *Discus* (*D.*) *ruderatus ruderatus* (Hartm.). U. S. S. R., Ukraine, Kopyczyńce by Tarnopol, 1923, leg. W. Roszkowski.

Fig. 3. *Discus* (*D.*) *ruderatus pauper* (Gould). U. S. S. R., the Suputinskij reservation by Vladivostok, 1947, leg. I. M. Likharev (specimen No. 3).

Fig. 4. *Discus* (*D.*) *ruderatus pauper* (Gould). U. S. S. R., the Suputinskij reservation by Vladivostok, 1947, leg. I. M. Likharev (specimen No. 4).

Fig. 5. *Discus* (*G.*) *perspectivus* (Meg. v. Mühlf.). Poland, Bieszczady Mts., 1952, leg. A. Riedel.

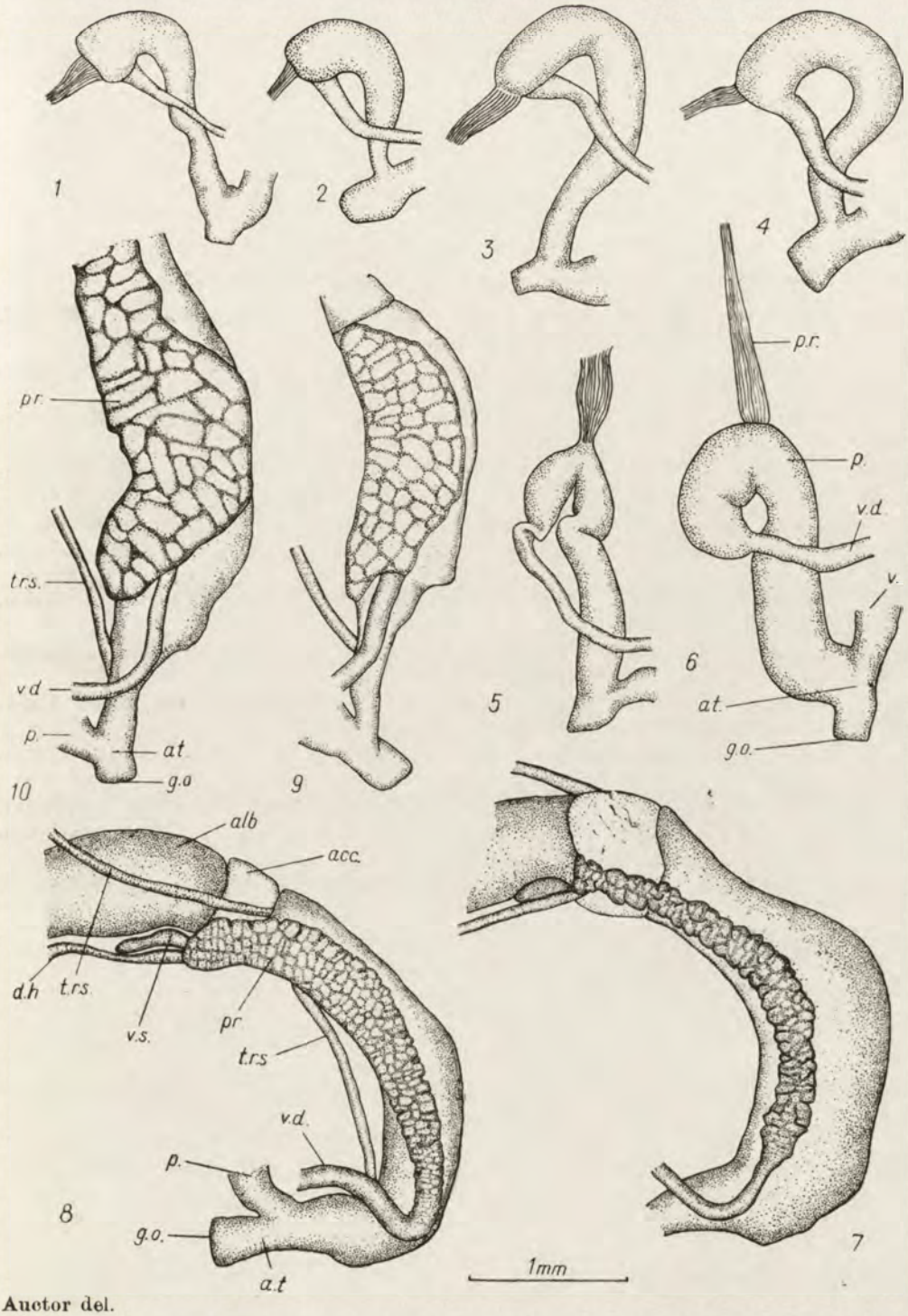
Fig. 6. *Discus* (*G.*) *rotundatus* (Müll.). Poland, Świętokrzyskie Mts., 1956, leg. A. Riedel.

Fig. 7. *Discus* (*D.*) *ruderatus ruderatus* (Hartm.). U. S. S. R., North Caucasus, Zheleznovodsk by Piatigorsk, 1954, leg. I. M. Likharev.

Fig. 8. *Discus* (*D.*) *ruderatus pauper* (Gould). U. S. S. R., the Suputinskij reservation by Vladivostok, 1947, leg. I. M. Likharev (specimen No. 3).

Fig. 9. *Discus* (*G.*) *perspectivus* (Meg. v. Mühlf.). Poland, Sudety Mts., Bardo Śląskie, 1956, leg. A. Wiktor.

Fig. 10. *Discus* (*G.*) *rotundatus* (Müll.). Poland, distr. Olkusz, Karlin, 1952, leg. R. Bielawski.



Auctor del.
T. Umiński

Plate IV

Shells

Fig. 11. *Discus* (*D.*) *ruderatus ruderatus* (Hartm.). Poland, Forest of Białowieża, 1957, leg. T. Umiński.

Fig. 12. *Discus* (*D.*) *ruderatus ruderatus* (Hartm.). Poland, Tatra Mts., Strążyska valley, 1955, leg. A. Kocówna.

Fig. 13. *Discus* (*D.*) *ruderatus ruderatus* (Hartm.). Poland, Karkonosze Mts., coll. R. Jetschin (?), the "scalaric" form.

Fig. 14 — 18. *Discus* (*D.*) *ruderatus pauper* (Gould). Amur, leg. B. Dybowski. 14 — specimen No. 1, 15 — specimen No. 2, 16 — specimen No. 4, 17 — specimen No. 5, 18 — series signed "4072", specimen No. 1.

Fig. 19. *Discus* (*G.*) *perspectivus* (Meg. v. Mühlf.). Croatia, Ogulin, coll. A. J. Wagner, specimen No. 4.

Fig. 20. *Discus* (*G.*) *perspectivus* (Meg. v. Mühlf,). Poland, Sudety Mts., Bardo Śląskie, 1954, leg. A. Wiktor.

Fig. 21. *Discus* (*G.*) *perspectivus* (Meg. v. Mühlf.). Poland, Sudety Mts., Bardo Śląskie, 1956, leg. A. Wiktor.

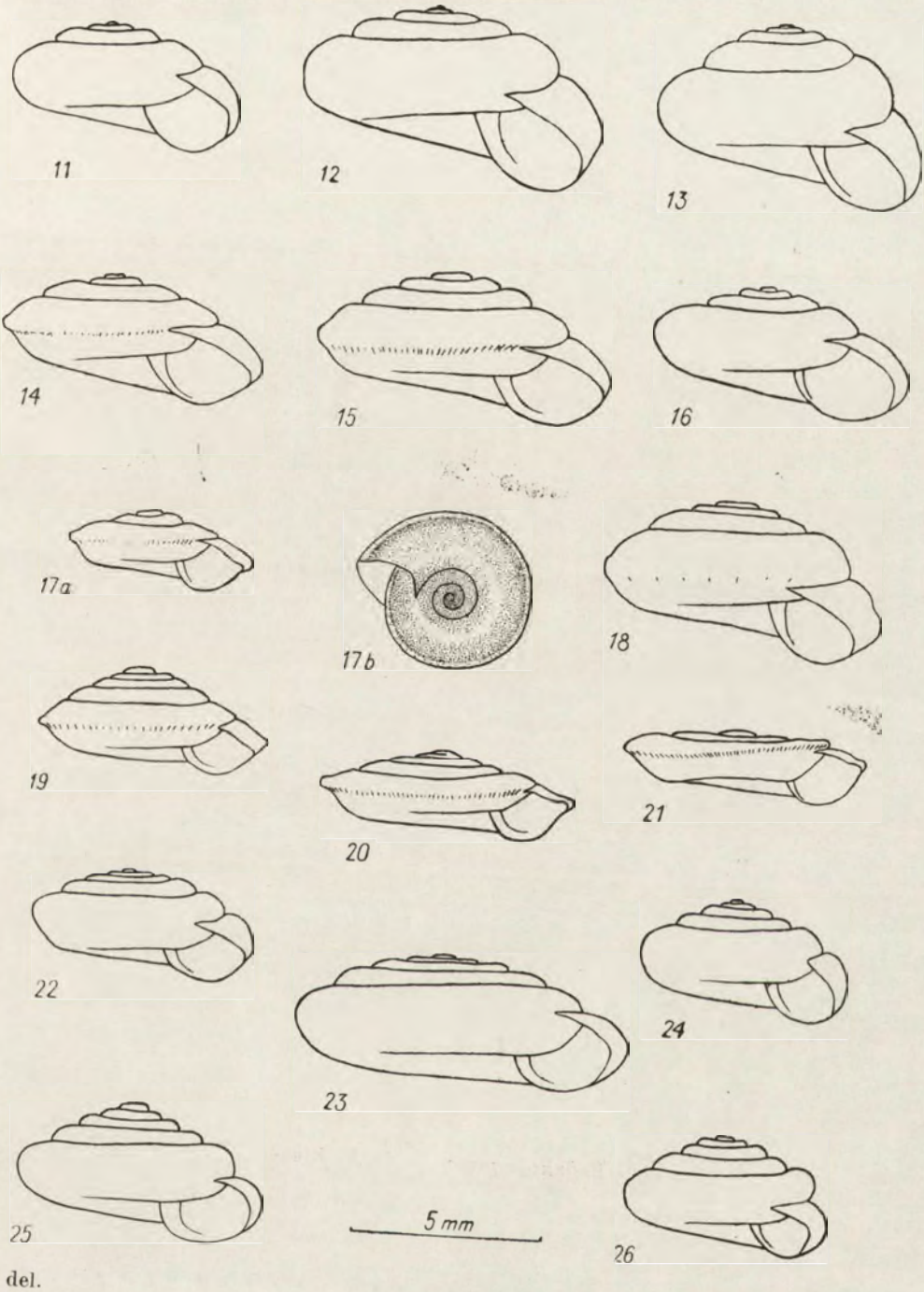
Fig. 22. *Discus* (*G.*) *rotundatus* (Müll.). Poland, Forest of Białowieża, 1957, leg. T. Umiński.

Fig. 23. *Discus* (*G.*) *rotundatus* (Müll.). Poland, Kazimierz on the Vistula, 1957, leg. A. Riedel.

Fig. 24. *Discus* (*G.*) *rotundatus* f. *abietina* (Bgt.). Crimea, Theodosia, coll. O. Retowski.

Fig. 25. *Discus* (*G.*) *rotundatus* f. *abietina* (Bgt.). Cave of Olevano by Naples, specimen No. 1.

Fig. 26. *Discus* (*G.*) *rotundatus* f. *abietina* (Bgt.). Palermo, Sicily, specimen No. 2.



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