Arch. Moll. | 101 | (5/6) | 263—273 | Frankfurt a. M., 17. 12. 1971

Revision of the genus *Paramastus* Hesse

(Emidae).

By

Joseph Heller,
Department of Zoology, Hebrew University, Jerusalem.

With 15 figures.

Introduction.

Since first established as a separate taxon by Hesse (1933: 181), *Paramastus* has received considerable attention (Forcart 1940, 1961; Zilch 1951, 1960; Brandt 1958). The ten species referred to this genus seem to combine a complex picture of a very wide-spread genus, scattered from Turkey to Saudi Arabia and from Syria to Libya. Fig. 1 represents the current opinions in Literature as to the systematics and distribution of the various species of *Paramastus*. Zilch (1951: 38-42) suggests that the Israeli snails are part of a wide-spread Rassenkreis, split into local subspecies in Cyprus, Lebanon-Israel, North Africa and Saudi Arabia.

This publication will be concerned with a revision of the genus *Paramastus*, based mainly upon systematic and zoogeographic inspection of *Paramastus* in Israel (with some ecological aspects influencing its distribution). The discussion will refer mainly to the validity of this proposed Rassenkreis.

The material studied was collected partly by Professor G. Haas over the past 38 years. Additional material was collected by the author throughout 1968-1970, during which a thorough survey of the Eninae of Israel (to be published later) was carried out. The area covered by this survey is bordered by the cease-fire line of 1967. We aimed at creating a dense grid of collecting sites about 5 kms. apart, and we have, at present, some two-hundred specimens from seventy localities. This local material was compared with specimens from Cyprus and Cyrenaica, part of which is in our collection and part of which was loaned to me through the kidness of Dr. A. Zilch of Frankfurt, Germany.

The *Paramastus* collection is kept at the Zoology Department of the Hebrew University, Jerusalem. — The specimens figs. 4-8 are deposited in the Senckenberg-Museum Frankfurt/Main (SMF 219153-6).

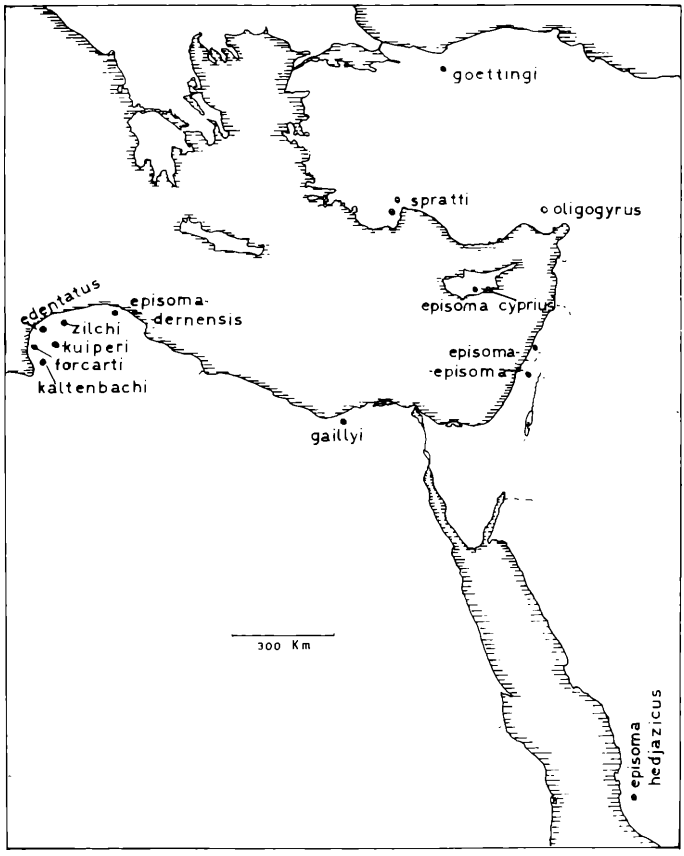


Fig. 1. Systematics and distribution of *Paramastus* according to current opinions in Literature.

Paramastus HESSE.

1933 *Paramastus* HESSE, Arch. Naturg., (N. F.), **2** (2): 181.

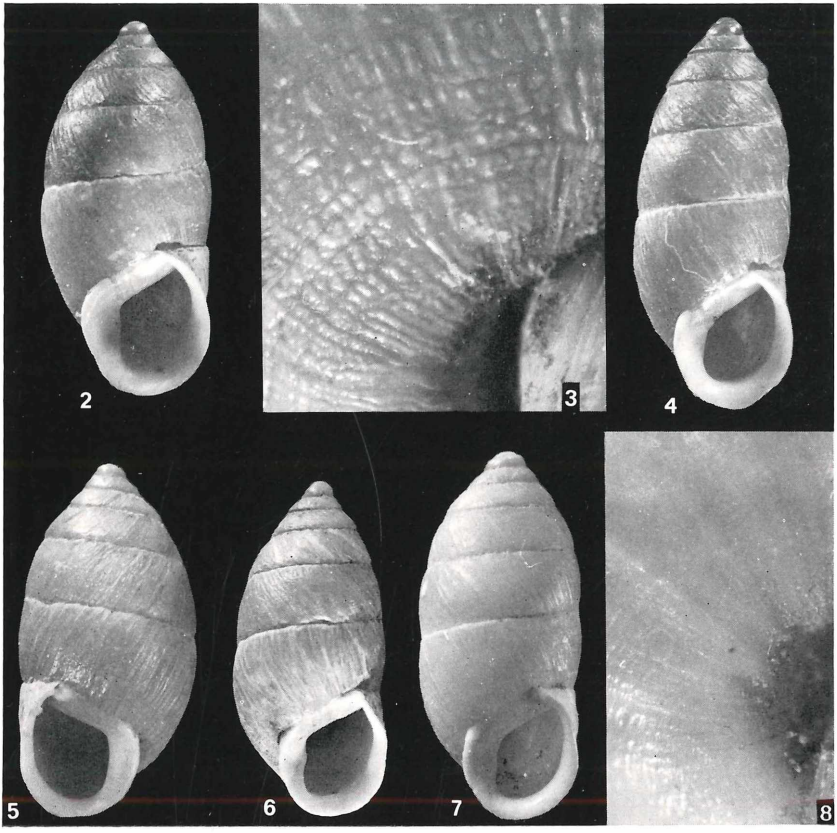
Type species: See statement under discussion.
Diagnose: The male excretory organs have a penial appendix.

Paramastus episomus (BOURGUIGNAT).

1821 *Helix (Cochlogena) obesata* FÉRUSSAC, Tabl. syst. Limaçons: 58 N° 451 from Sidon; nom. nud.
1837 *Bulimus (Mastus) obesus* BECK, Ind. Moll. Mus. Christ. Fred.: 73, from Sidon; nom. nud.

1853 *Bulimus obesatus*, — BOURGUIGNAT, Cat. rais. Moll. terr. fluv. rec. SAULCY: 39 partim; non *Bulimus obesatus* WEBB & BERTHELOT, 1833 from the Canary Islands.
1857 *Bulimus episomus* BOURGUIGNAT, Amén. Malac., 2: 26, pl. 3 figs. 5-7. Type-locality: Environs of Nazareth.
1857 *Bulimus pseudepisomus* BOURGUIGNAT, Amén. Malac., 2: 27, pl. 3 figs. 8-10. Type-locality: Environs of Beirut.

Description of shell (Figs. 2-6). Shell dextrorsal, ventricose, very thick, olive-green to yellow, with dark apex. It is composed of $6^1/_4$-8 whorls. The protoconch consists of two smooth whorls. All other whorls are striated. The



Figs. 2-6. *Paramastus episomus*. — 2) typical, from Yearot, Hacarmel, Mount Carmel, Israel; 3) detail of fig. 2, showing pronounced reticulation near umbilicus; 4) elongate shell from Marda, Samaria, Israel; 5) anormally sinistrose shell from Neve Yaaqov (near Jerusalem); 6) from Beit Iba (near Nablus), the contour of the mouth is typically "cyprius" (see text).

Figs. 7-8. *Paramastus cyprius*. — 7) from Paramali, Cyprus, the contour of the mouth is "episomus" (see text); 8) detail of fig. 7, showing weak reticulation near umbilicus.

striae are extremely pronounced and wrinkled near the sutures of the penultimate whorl. Longitudinal lines crossing the striae create a reticulation most distinct near the umbilicus. The diameter of the penultimate whorl is in most specimens smaller than that of the preceding whorl, only exeptionally it is larger. The first three whorls after the protoconch are very flat and separated by a shallow suture. The prepenultimate whorl is slightly convex. The aperture is roundish. Its height is less than half the shell's height. The outer and inner lips insert distally on the penultimate whorl and are sometimes connected by a callus. The peristome is reflexed outwards, but not backwards.

Measurements

Shell height	15·8 -22·1 mm
Max. diameter	7·8 -10·3 mm
Min. diameter	7·5 9·6 mm
Mouth height	6·3 8·6 mm
Mouth diameter	5·1 7·0 mm
$\frac{\text{Shell height}}{\text{Max. diameter}}$	1·73- 2·38
$\frac{\text{Shell height}}{\text{Mouth height}}$	2·23- 2·89
$\frac{\text{Mouth height}}{\text{Mouth diameter}}$	1·10- 1·38

Graphic representation of the frequency of the shell height and of the relations between the various measurements are given in figs. 9-11.

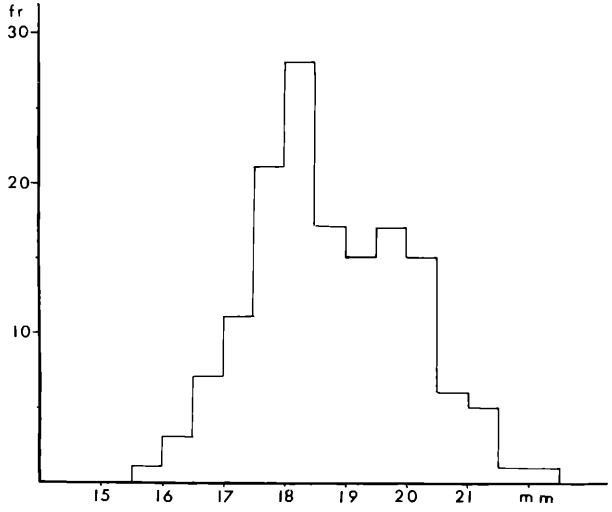


Fig. 9. Frequency of shell height of *Paramastus episomus* from Israel.

A peculiar anomaly worth mentioning concerns a rare shell, found North of Jerusalem which is sinistrose (Fig. 5).

Reproductive System (Figs. 12-14): Three specimens from Meron, Mt. Carmel and Umm Fahem have been dissected.

The albumin gland is bent, grooved at its distal end and of creamish colour. The uterus is much longer than the vagina, and widens slightly at its proximal end. The diverticle of the receptaculum seminis is slim, of uniform diameter and longer than the pediculus. The combined length of the bursa and its ductus is less than half the length of the diverticle.

The vas deferens curves around the vagina and thickens slightly upon ascending towards the epiphallus. The stocky epiphallian flagellum is very short (less than 2·0 mm), very thick (about 1·0 mm) and characteristically bent near its middle, forming a blunt angle. The epiphallus is more than twice as long as the penis, much thinner, and without caecum. The straight penial flagellum is a

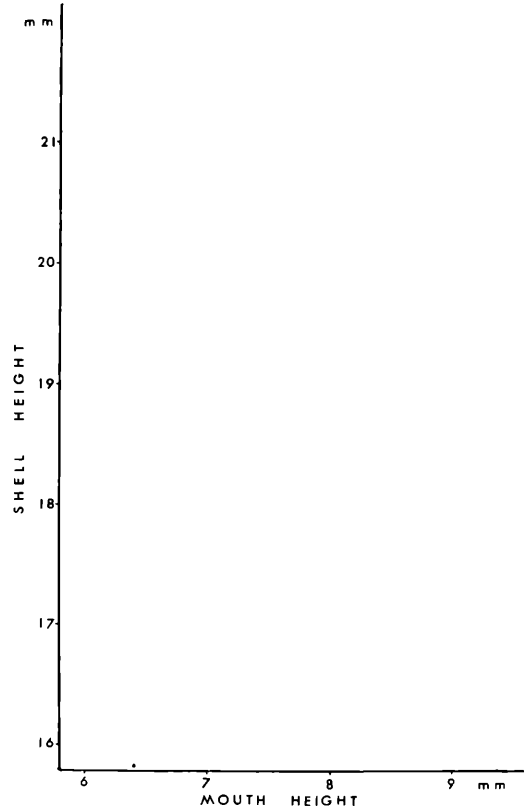


Fig. 10. Relation between shell height and mouth height in *Paramastus episomus* from Israel.

robust blind sac, 3-4 mm in length, nearly as long as the remaining part of the penis. A very long, slim appendix is present. It is longer than the penis, and continued distally by a short proximal and a longer distal part. The penial and appendicular retractors unite to a common muscle inserting at the diaphragma.

Distribution: Fig. 15, on which the seventy odd localities were plotted, represents the distribution of *P. episomus* throughout Israel. The species is sporadically distributed in the hilly areas of Upper Galilee, Lower Galilee (west of the watershed), and Mount Carmel. It is rather common throughout the hilly areas of Samaria and Judea, with an isolated population in the Gilboa and a few populations along the coast. The southernmost point is Hebron. It is completely absent from the Golan Heights and from Sinai. The absence from Sinai is of special significance since it means that there is no connection between the areas of *P. episomus* and *P. gaillyi*, being isolated by a distance of nearly 450 kilometers.

Outside Israel the distribution area continues northwards into Lebanon, where it is known from Sidon and Beirut (FÉRUSSAC 1821: 58 = *Helix (Cochlogena) obesata*), Brumana and Beit Meri (GERMAIN 1921: 295), and Nahr el Kelb (PALLARY 1939: 41).

Ecological aspects: Climate and substrate are the two ecological factors which have the most pronounced influence upon the distribution of *P. episomus*.

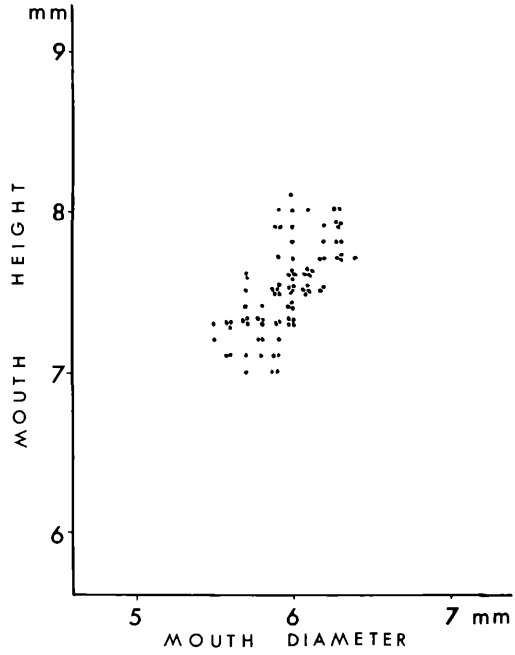
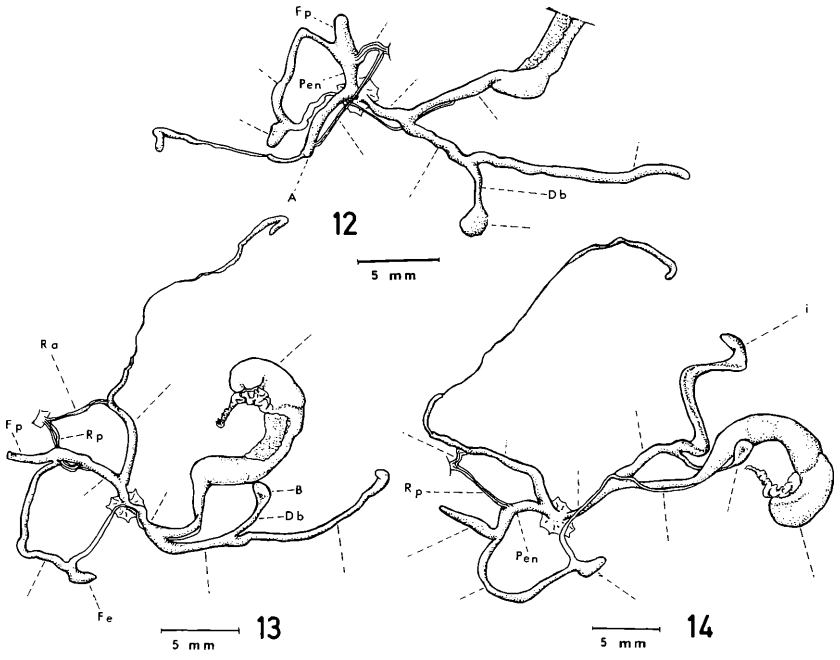


Fig. 11. Relation between mouth height and diameter in *Paramastus episomus* in Israel.



Figs. 12-14. Reproductive system of *Paramastus episomus.* — 12) from Mount Meron, Israel; 13) from Mount Carmel, Israel; 14) from Umm el Fahm, Israel. — Abbreviations: A = Appendix of the penis, Ab = Albumen gland, B = Bursa of the receptaculum seminis, D = Ductus bursae of the receptaculum seminis, E = Epiphallus of the penis, Fe = Flagellum of the penial epiphallus, Fp = Fagellum of the penis, Ped = Pediculus of the receptaculum seminis, Pen = Penis, Ra = Retractor of the penial appendix, Rp = Penial retractor, U = Uterus, V = Vagina.

All specimens (but for the isolated samples of Mount Gilboa) were found in zones with at least 500 mm. rain per year. The distribution border of the species actually coincides in full the 500 isohyate (see map 2), leaving little doubt that lack of precipitation is the major limiting factor preventing its distribution southwards.

Substrate is of supreme importance to *episomus* because it is an obligatory rock-dwelling snail, to be found only in the vicinity of stony outcrops, rocks, and in the crevices of boulders. I have never found it in a plain, a plateau or a valley. The rock preferred is limestone, dolomite or kurkar (a hardened calcareous sanddune). It is entirely absent from basalt, the rock covering vast areas of the Golan Heights and the Eastern Gallilee. It is also absent from chalk stone. The distribution of *P. episomus* shows also a very close correlation to the distribution of soils, 95% of the localities being on Terra Rossa. The remaining 5% were on brown Rendzina and Hamra.

Associating species found together with *P. episomus* in the rock crevices of the Mediterranean region of Israel are *Buliminus labrosus, B. sidoniensis, Jaminia*

septemdentata, Levantina caesareana, L. hierosolyma and *Metafruticicola berytensis*. In comparison to these very abundant snails, *P. episomus* is by no means frequent. The biggest number of empty shells I ever found at one site was fourteen, two to four being the usual. Live snails are found extremely seldom.

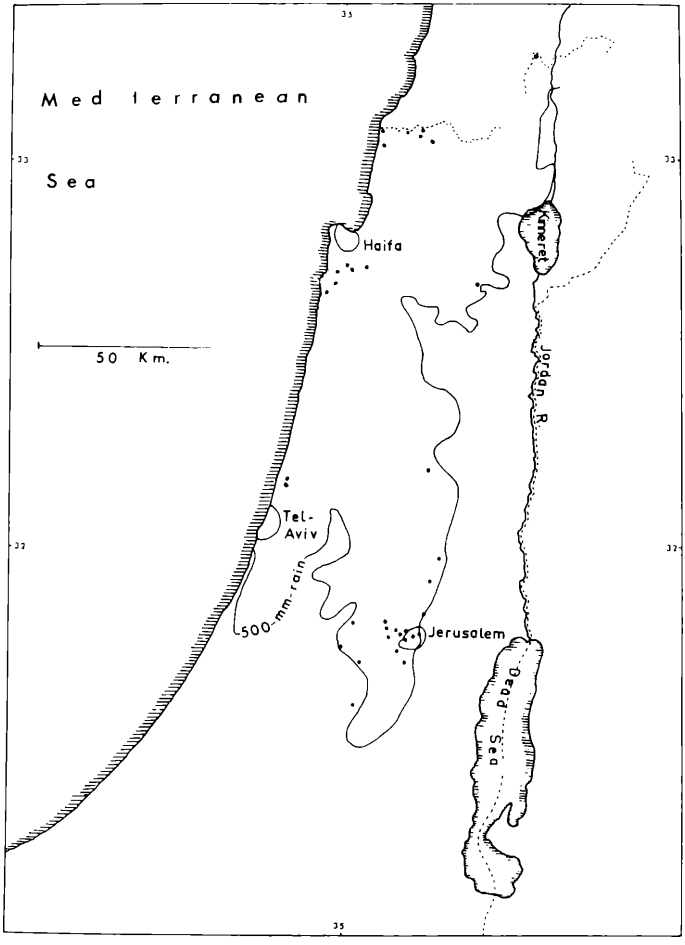


Fig. 15. Distribution map of *Paramastus episomus* in Israel.

Paramastus cyprius Zilch.

1854 *Chondrus attenuatus* Mousson, Mitth. naturf. Ges. Zürich, **3** (102): 382. Type-locality: Cypria on limestone between Kyrenia and „Cérines"; homonym with *Chondrus attenuatus* Krynicki 1836, from the Crimea. — Mousson 1854, Coqu. terr. fluv. rec. Bellardi: 36-37, 57-58, pl. fig. 7.

1897 *Buliminus (Mastus) sabaeanus*, — KOBELT & ROLLE, Iconogr. (Suppl. 1): 58, pl. 8 figs. 8-11; non *Bulimus sabaeanus* BOURGUIGNAT, 1876 from Arabia.
1933 *Ena episoma*, — HESSE, Arch. Naturg., (N. F.) 2 (2): 180-181, fig. 20; non *Bulimus episomus* BOURGUIGNAT, 1857 from Israel.
1951 *Paramastus episoma cyprius* ZILCH, Arch. Moll., 80 (1/3): 39; nom. nov. pro *Chondrus attenuatus* MOUSSON, 1854.

Description of shell: The shell of *P. cyprius* differs from that of *P. episomus* by its horny-reddish, not olive-green to yellow colour, and the smoother, more delicately striated surface (Figs. 7-8).

ZILCH (1951: 38-39) suggests the ratio $\frac{\text{mouth height}}{\text{mouth diameter}}$ and the contour of the mouth, mainly the outer lip, as differential criterions. Both these characters are very variable and show considerable overlap. Fig. 6-7 show a Cyprian shell with an "*episomus*" contour and, vis versa, an Israeli shell with a "*cyprius*" mouth.

The reproductive organs of *cyprius* as described by HESSE (1933: 180-181, fig. 10 sub *Ena episoma*) differ from those of the genuine *episomus* from Israel by the epiphallian flagellum which is rudimentary (not stocky and thick), by the presence of an epiphallian caecum and by the penial flagellum which is smaller, with an unciform distal end.

Distribution: Cyprus.

Cyrenaeus n. gen.

Type-species: *Buliminus (Mastus) attenuatus f. edentatus* STURANY, 1908 = *Paramastus edentatus* (STURANY) ZILCH 1951.

Diagnosis: *Cyrenaeus* differs from *Paramastus* in that the male reproductive organs lack a penial appendix. It differs from *Mastus* by its reticulated shell and by its epiphallum which inserts laterally, not distally, into the penis.

Description: ZILCH (1951: 33-42) refered, on conchological reasons, the four species *kaltenbachi* ZILCH, 1951, *forcarti* ZILCH, 1951, *edentatus* (STURANY, 1908), and *episomus dernensis* ZILCH, 1951 to the genus *Paramastus*. Their shell is finely reticulated by delicate, oblique ribstriae, crossed by spiral grooves.

BRANDT (1958: 13-16, figs. 2-7) described the reproductive system of *forcarti, edentatus zilchi* BRANDT, and *P. edentatus edentatus*. ZILCH (1960: 59-60, pl. 9 fig. 5) described that of *P. kuiperi* ZILCH, 1960. The reproductive organs of these species lack the penial appendix of the male excretory organs and the epiphallus inserts laterally into the penis. In this they differ from *Mastus*, where the epiphallus inserts distally (FUCHS & KÄUFEL 1936: 566).

Discussion.

Paramastus was established as a separate section (of the genus *Ena*) on account of the peculiar structure of its reproductive system (HESSE 1933: 181). These anatomical pecularities were credited much more importance by FORCART (1940: 160), who classified *Paramastus* as an independent genus. In 1951 ZILCH suggested a conchiological criterion for typifying this genus: The existence of

a delicate reticulation, created by fine longitudinal grooves crossing the growth lines. Upon these conchiological grounds, he referred to *Paramastus* four Cyrenaican species *(kaltenbachi, forcarti, edentatus* and *episoma dernensis),* all with reticulated shell. Furthermore, he suggested to regard *episomus* as a once very widespread species which in later stages, owing to geographical isolation, split into five subspecies: In Syria-Israel *(e. episomus),* Cyprus *(e. cyprius),* West Arabia *(e. dedjazicus),* Cyrenaica *(e. dernensis)* and North West Egypte *(e. gaillyi).*

Results of the present work largely refute this picture. Examination of the reproductive organs of *P. episomus* from Israel resulted that this species and *P. cyprius* (described by HESSE 1933 fig. 20 as *Ena episoma*) are two different species. Further, in contrast to *episomus* and *cyprius* which have a well developed appendix, all Cyrenaican species lack the penial appendix. They therefore do not belong to the genus *Paramastus* or even to the subfamily Eninae. Rather, they should be assigned to the Chondrulinae, typified by both HESSE (1933: 153-160) and FORCART (1940: 229-254) as the only subfamily of Enidae lacking the penial appendix. This means that the big, widespread "*Paramastus episomus* Rassenkreis" does not really exist, since "*Paramastus episomus*" *dernensis* is not a *Paramastus* at all. Similary, the superficial resemblance of the shell of *hedjazicus* and *gaillyi* to *Paramastus* means little without inspection of their genital systems and there is no justification at present to refer them to this genus, all the more so to the species *episomus.*

These systematic conclusions are summed up in the following list:

A. Species with examined reproductive organs.

Eninae		
Paramastus HESSE	*episomus* BOURGUIGNAT	Israel, Lebanon
	cyprius ZILCH	Cyprus
Chondrulinae		
Cyrenaeus n. gen.	*edentatus* STURANY	Cyrenaica
	kaltenbachi ZILCH	Cyrenaica
	forcarti ZILCH	Cyrenaica
	dernensis ZILCH	Cyrenaica
	kuiperi ZILCH	Cyrenaica

B. Species hithero classified within the genus *Paramastus,* without examination of their reproductive organs.

Their systematic relationships yet unclarified.

hedjazicus BOURGUIGNAT	SW Arabia
gaillyi WESTERLUND	NW Egypt
spratti PFEIFFER	S Anatolia
oligogyrus BOETTGER	S Anatolia
goettingi FORCART	NW Anatolia

Due to this classification ZILCH's conchiological criterion for recognizing *Paramastus,* namely reticulation of the shell, should be disregarded, since according to it the Cyrenaican Chondruline *Cyrenaeus* possesses it too. We have thus

at present no conchiological criterion for separating *Paramastus* from other Enids and we can — as yet — rely only on inspection of the reproductive system.

While placing *Cyrenaeus* under the Chondrulinae I must note that its systematic position may also be regarded otherwise: As a group of *Paramastus* which, during evolution, lost its penial appendix. This alternative (kindly pointed out to me by Dr. FORCART) through possible, seems somewhat improbable: All Cyrenaican species lack the penial appendix. The genital differences are thus of generic level, and were achieved very early, before the splitting up of the genus into species. It would be surprising if such an ancient splitting off of the *Paramastus* stock, concerning such drastic changes in genital organs, were to be accompanied by such minor changes in the shell. Rather, it seems that *Cyrenaeus* is a Chondruline with both shell and genital system similar to *Mastus* (to whom it is closely related), the shell differing by its reticulation, the genitalia by the lateral insertion of the epiphallus.

Acknowledgements.

I am grateful to Prof. G. HAAS for his encouragement and criticism throughout the work. I am especially indebted to Dr. FORCART, Basel, for critically reading the manuscript and for offering much valuable advice. Thanks are further due to Dr. ZILCH, Frankfurt, for lending me material from Cyprus and Libya. Mr. A. NIV kindly helped me with the photographs, and Mrs. M. ROSENTHAL with technical assistance.

References.

BRANDT, R. (1958): Über neue und wenig bekannte Binnenmollusken der Cyrenaika. — Arch. Moll., **87** (1/3): 1-18.

FORCART, L. (1940): Monographie der türkischen Enidae (Moll., Pulm.). — Verh. naturf. Ges. Basel, **51**: 160-162, 243.

— — — (1961): Systematisches Verzeichnis der von Herrn KLAUS-JÜRGEN GÖTTING 1960 in der Türkei gesammelten Mollusken und Neubeschreibung einer *Paramastus* Art. — Arch. Moll., **90** (4/6): 175-180.

FUCHS, A. & KÄUFEL, F. (1936): Anatomische und systematische Untersuchungen an Land- und Süßwasserschnecken aus Griechenland und von den Inseln des Ägäischen Meeres. — Arch. Naturg., (N. F.) **5** (4): 559-567

GERMAIN, L. (1921): Mollusques terrestres et fluviatiles des Syrie. — Voyage zoologique d'HENRI GADEAU DE KERVILLE en Syrie (Avril-Juin 1908), **1**: 291-295.

HESSE, P. (1933): Zur Anatomie und Systematik der Familie Enidae. — Arch. Naturg., (NF) **2** (2): 145-224.

PALLARY, P. (1939): Deuxième addition à la faune malacologique de la Syrie. — Mem. Inst. Égypt., **29**: 41.

ZILCH, A. (1951): Ergebnisse zoologisch-geologischer Sammelreisen H. KALTENBACH's in NO-Afrika, 5: Familie Enidae. — Arch. Moll., **80** (1/3): 33-46.

— — — (1960): Neue Landschnecken aus der Cyrenaika. — Arch. Moll., **89** (1/3): 57-60.