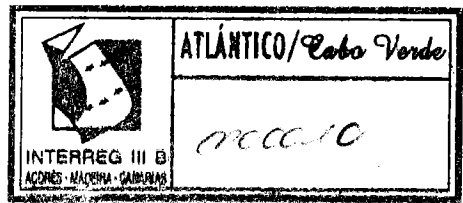


Results of the Zoological Expedition of Prof. Dr. HÅKAN LINDBERG
to the Cape Verde Islands in the winter 1953—54. N:o 19.



The Land and Freshwater Molluscs of the Cape Verde Islands

by

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With one map and five figures

Communicated 7th march 1958 by HÅKAN LINDBERG and PONTUS PALMGREN



HELSINGFORS 1958

INTRODUCTION

This study is based partly on my collections in the Cap Verde Islands in winter 1953—54, partly on literature studies. The material has been determined at the Riksmuseum in Stockholm, where prof. NILS ODHNER and doc. BENGT HUBENDICK have given me their assistance, and at the Zoological Museum in Helsingfors. I have much pleasure in expressing my gratitude to prof. ODHNER and doc. HUBENDICK, and also to prof. ALEXANDER LUTHER, Helsingfors, who taught me the principles of malacology.

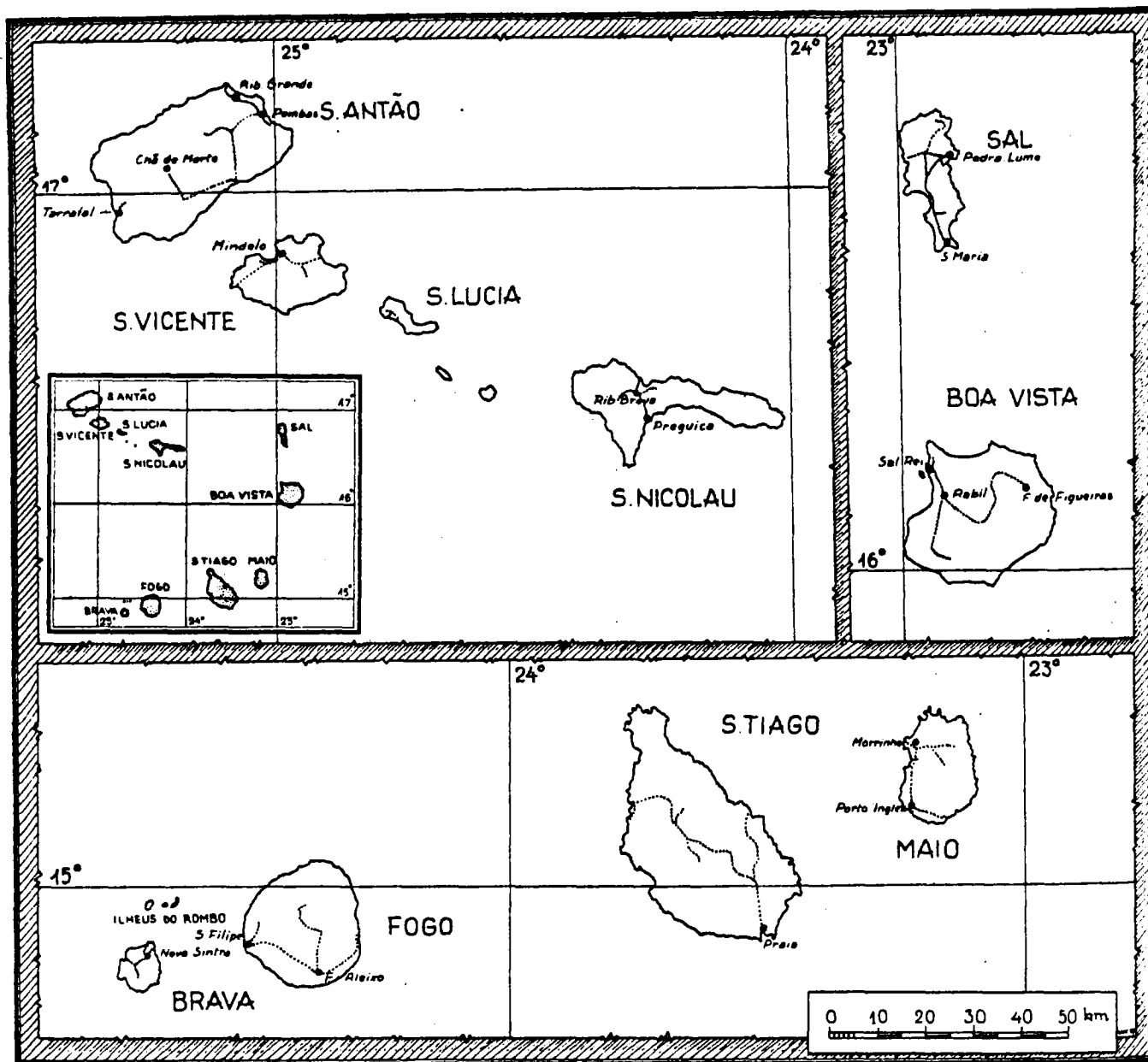
THE NATURAL CONDITIONS OF THE CAP VERDE ISLANDS

The Cap Verde Islands, which are situated about 550 km to the west of Cap Verde between 14° and 17° N and 22° and 26° W, consist of 15 greater and a number of smaller islands and have a total area of 3 851 km². They are chiefly built up of basalts, marine limestone and to some extent of granite. The relief is very pronounced except on the three eastern islands.

The climate is dry, temperate and oceanic. The average temperature is about 24.5° C, the yearly amplitude 4.5° C. Almost the entire rainfall is in August—October; May and June have practically no rain. The yearly rainfall varies considerably from island to island depending on the height of the mountain ranges and their direction in relation to the tradewind.

The vegetation is rich only in the cloud belt and in valleys with mountain brooks; in the eastern islands there are great, practically vegetationless, desert areas. When the islands were discovered they were covered by forests but now they are entirely devastated. The activity of man has also changed the composition of the flora by introducing Mediterranean and South American species which have spread at the cost of the original species.

The positions and areas of the islands can be seen from the following scetch-map.



COLLECTIONS AND PUBLICATIONS CONCERNING THE MOLLUSC FAUNA OF THE CAP VERDE ISLANDS

The first report about the mollusc fauna of the Cap Verde Islands was given in 1827 by DE FÉRUSAC when he mentioned *Carychium minus* Fer. from S. Tiago; this information, however, is probably incorrect.

In 1831 KING & BRODERIP announced *Pupa subdiaphana* King (*Zootecus insularis* Ehr.) from S. Tiago.

In 1852 PFEIFFER augmented the number by two, *Helix (Leptaxis) bertholdiana* and *corneovirens*, of which the latter evidently is wrongly labeled.

In 1852 SHUTTLEWORTH announced *Helix (Leptaxis) myristica*.

In 1854 ALBERS announced *Helix (Leptaxis) sarta* and *bollei*.

In 1856 BENSON announced three species collected by LAYARD in S. Vicente: *Pupa (Gastrocopta) acarus*, *Napaeus (Pupoides) gemmula* and *Achatina (Caecilioides) spiculum*.

The first summary was published by REIBISCH in 1856; it is based on A. STÜBEL's collections and comprises 11 species, 5 of which are new. The species described by Benson were not known to him.

DOHRN is the first to have made more comprehensive collections; in 1869 he published a list with 29 species, 17 of which were new to the islands.

In 1873 MORELET published a list, comprising 40 species, 9 of which were new, collected by BOUVIER and CESSAC in 1870.

In 1878 WOLLASTON published the till now most exhaustive study on the molluscs of the Cap Verde Islands; it comprises 41 species one of which was new.

In 1881 ROCHEBRUNE published a list of 54 species, 12 of which were new. It is based on a till then untreated part of BOUVIER's and CESSAC's material.

In 1909 NOBRE published a list of the molluscs of the Portuguese colonies; it does not bring any new species from the Cap Verde Islands in spite of collections by CARDOSO and NEWTON.

In 1926 GERMAIN published an article, based on newer research work, in which he revised the nomenclature and treated the composition of the fauna. He does not bring any new species, but he gives the result of FEA's collections in 1898.

In 1946 FISCHER-PIETTE treated the Macaronesian mollusc fauna in a compilation about Macaronesia.

My collections took place in all islands except Branco and Razo from 24. 11. 53 till 22. 3. 54, by handnetting of the vegetation, sifting of mouldering parts of plants or directly by picking the animals from their hiding-places under stones, rind etc. The collecting in the southern islands, which I last visited, was made difficult by the beginning of the dry period which made the animals inactive and difficult to find.

LIST OF FROM THE CAP VERDE ISLANDS KNOWN LAND AND FRESHWATER MOLLUSCS

The nomenclature and the systematics according to Ehrmann, Fischer-Piette and others. When Fischer-Piette, Germain or Wollaston use synonyms this will be indicated. Wollaston has a complete list of older synonyms. Several of the earlier authors include littoral species in the freshwater fauna; I have excluded them.

PROSOBRANCHIA

Hydrobiidae

1. *Hydrobia ventrosa* Montagu

Wollaston: *Hydrobia acuta* Drap; Germain, Fischer-Piette: *Paludestrina acuta* Drap.

Dohrn: S. Nicolau; Bouvier & Cessac: S. Antão, Sal.

Distribution: Fresh and brackish water in Europe and North Africa.

2. *Hydrobia?* sp.

Panelius: Sal, Pedra Lume, 21. 1. 54. A great number of specimens from a saline basin with saturated salt solution and rich alga vegetation.

According to dr. Hubendick this species is not *H. ventrosa* Montagu which was found by Dohrn in S. Nicolau and by Bouvier & Cessac in S. Antão and Sal. I am not able to decide whether it belongs to the genus *Hydrobia* or not.

Pomatiasidae

3. *Pomatias elegans* Müller

Wollaston, Germain, Fischer-Piette: *Cyclostoma elegans* Müller.

Cessac: S. Tiago.

Distribution: Europe.

Melaniidae

4. *Melanoides tuberculata* Müller

Wollaston, Germain, Fischer-Piette: *Melania tuberculata* Müller.

Reibisch; Dohrn: S. Antão, S. Nicolau; Lowe: S. Vicente (subfossilized); Bouvier & Cessac: S. Antão, S. Tiago; Cardoso: A. Antão; Newton: Boa Vista.

Panelius: S. Antão, Pombas, 26. 12. 53. 31 spec. from watering ditches in a garden. Rib. Grande, 29. 12. 53. 22 spec. from a rock wall with trickling water under a banana plantation. Tarrafal, 12. 3. 54. About 30 adults and a number of young specimens from a mountain brook surrounded by plantations.

Distribution: The coasts of Africa, South Asia and the East Indies.

The species is variable which can be seen in the way in which the animals from the three localities differ from each other in several characters:

	Pombas	Tarrafal	Rib. Grande
Ground colour	Light greenish brown	Whitish — light greyish yellow	Whitish — light greyish yellow
Colour pattern	Indistinct	Distinct	Distinct
Suture	More distinct	Less distinct	Less distinct
Width of shell ¹	6.80 ± 0.08 mm	6.46 ± 0.19 mm	6.24 ± 0.08 mm

¹ Width of shell means here the average of the width of the shell 15 mm from the apex in animals more than 20 mm long; that is a measure of the speed at which the coils grow wider.

The differences between the three populations probably depend on the different biotops they inhabit. The Pombas animals live in muddier and less lit water than the others and therefore they are darker and more plainly coloured. Quickly streaming water probably favours the development of a narrow shell with shallow sutures. Hence these features in the Tarrafal and Rib. Grande populations.

BASOMMATOPHORA

Physidae

5. *Physa forskali* Ehrenburg

Germain: *Bullinus forskali* Ehr.

Dohrn: S. Tiago; Fea: S. Nicolau.

Panelius: S. Nicolau, Rib. Brava, 5—19. 12. 53. 2 adults and one young specimen under stones in a brook.

Distribution: Africa.

Lymnaeidae

6. *Lymnaea natalensis* Krauss

Wollaston, Germain, Fischer-Piette: *Lymnaea stübeli* Reib.

Stübel: S. Antão; Dohrn: S. Antão, S. Nicolau, S. Tiago, Brava; Wollaston: S. Tiago, Brava.

Panelius: S. Tiago, Rib. Boa Entrada, 9. 2. 54, 82 spec. Brava, Rib. Fajã de Agua, 25. 2. 54, 18 spec. On stones in brooks.

Distribution: Africa except the extreme north.

The older authors considered this a separate species, *L. stübeli* Reib., whereas Germain and Fischer-Piette think that the Cap Verde animals are but a variety of *L. peregra* Müller. According to dr. Hubendick who has examined the anatomy of my specimens it is *L. natalensis*, a species which perhaps is a subspecies of *L. auricularia* L. The radula (fig. 1) of my specimens corresponds to the pictures of the radula of *natalensis* by Hubendick.

7. *Lymnaea auricularia* Linne

Wollaston, Germain, Fischer-Piette: *Lymnaea ribeirensis* Reib.

Stübel: S. Antão; Dohrn: S. Antão.

Panelius: S. Antão, Campo da Cão, 30. 12. 53. 63 spec. from stones in a brook.

Distribution: Europe and Asia except the extreme north and south.

The specimens from the Cap Verde Islands have by the older authors been considered as belonging to a separate species, *L. ribeirensis*, while Germain and Fischer-Piette consider them as a variety of *L. auricularia* L. Hubendick, who has examined the anatomy of my specimens, states: «corresponds anatomically with *L. auricularia* and *natalensis*. Is concologically a distinct type.» Because of following reasons I consider it more probable that we are dealing with *auricularia* and not with *natalensis*:

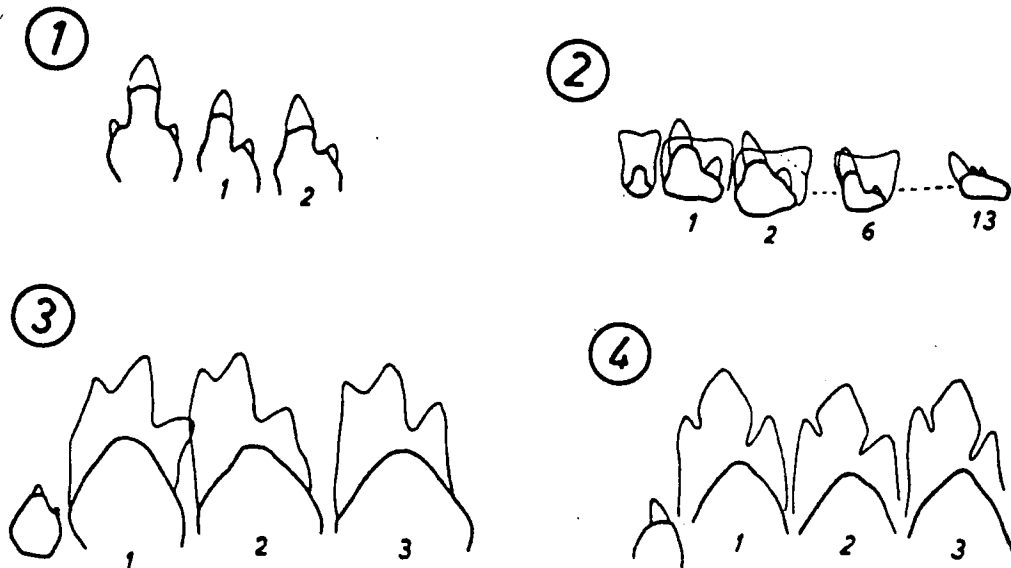


Fig. 1. Radulas of: 1. *Retinella* sp., 2. *Pupoides gemmula* Bens., 3. *Lymnaea natalensis* Krauss, 4. *Lymnaea auricularia* L. Magnification 700 X.

The shell (fig. 4) is much more similar to that of *auricularia*; according to Hubendick's pictures it is extremely unusual that *natalensis* becomes as broad as the specimens from the Cap Verde Islands. Moreover it is not probable that *natalensis* should have developed two different races on the same island, S. Antão. The radula (fig. 1) is much more similar to that of *auricularia* concerning the relative size of the inner sidecone. (In Hubendick's pictures we can state that this cone is relatively greater with *auricularia* than with *natalensis*; this is, however, not a rule without exception.) Should the species have been introduced with man, it is more probable, considering that practically all introduced species are Mediterranean, that a type reminding *auricularia* should have been brought for instance from the Iberian Peninsula, where we find *auricularia* but not *natalensis*, than from West Africa, where only the latter occurs.

The Cap Verde specimens differ from *auricularia* as well as from *natalensis* and moreover from all other *Lymnaea* species whose radulas Hubendick has reproduced, owing to the fact that the central cone gets narrower at the base. Whether this feature has originated in the Cap Verde Islands or for instance in the Iberian Peninsula is impossible to decide as I have no material for comparison.

Planorbidae

8. Gyraulus? sp.

Wollaston, Germain, Fischer-Piette: *Planorbis coretus* Desh.

Dohrn: S. Nicolau, S. Tiago; Fea.

Panelius: S. Antão, Rib. Grande, 27. 12. 53, 24 spec, Rib. do Braz, 28. 12. 53, 16 spec., Campo da Cão, 30. 12. 53, 31 spec., Mte. Conceição, 1. 1. 54, 19 spec., Chã de Morte-Lagedo, 6. 1. 54, 24 spec. In brooks on stones covered with alga.

Dohrn identifies the species as *Planorbis coretus* Desh., Wollaston and Germain follow him. Fischer-Piette doubts the correctness of this decision and states that *P.*

coretus is a *Planorbis* s.s. while the Cap Verde species according to Germain belongs to *Diplodiscus*. Hubendick, who has seen my specimens, states: »Probably a *Gyraulus*, eventually close to *G. laevis*.» As an exact anatomical investigation was impossible to do, the question of which species we deal with must be left unanswered; in any case we have probably not to do with *P. coretus*.

Ancylidae

9. *Ancylus milleri* Dohrn

Dohrn: S. Tiago

Distribution: The Cap Verde Islands.

STYLOMMATOPHORA

Succineidae

10. *Quickia wollastoni* Dohrn

Wollaston, Germain: *Succinea wollastoni* Dohrn

Dohrn: S. Nicolau; Fea: S. Nicolau.

Panelius: S. Nicolau, 16 and 19. 2. 53. 2 adults and 2 young specimens from debris at the sides of a brook.

Distribution: *Q. wollastoni* the Cap Verde Islands, *Q. concisa* the coasts and islands of the Guinea Bay.

Odhner classifies (private communication) the closely related *Q. concisa* Morelet to the genus *Quickia* Odhner, and thus also *wollastoni* should have this name. It differs from *concisa* by lower coils and broader aperture; whether it is a different species or just a race of *concisa* I am not able to decide.

11. *Succinea lowei* Dohrn

Dohrn: S. Antão.

Distribution: The Cap Verde Islands.

Limacidae

12. *Deroceras agreste* Linne

Dohrn?: S. Antão, S. Nicolau.

Panelius: S. Antão, Pombas, 23. 12. 53, 5 spec. Rib. Grande, 29. 12. 53, 7 spec. Campo da Cão, 30. 12. 53, 6 spec. Mte. Conceição, 1. 1. 54, 17 spec. Chã de Morte — Lagedo, 6. 1. 54, 6 spec. S. Vicente, Mte. Verde, 29. 11. 53, 7 spec. S. Nicolau, Rib. Brava, 5—19. 12. 53, 21 spec. S. Tiago, Rib. Boa Entrada, 9. 2. 54, 10 spec. Brava, Fajã de Agua, 25. 2. 54, 13 spec. In moist places, as among mouldering plant debris, under stones, at sides of brooks and in the cloud belt.

Distribution: Europe, spread over all Macaronesia.

Dohrn's material has been lost but contained probably this species.

13. *Milax gagates* Draparnaud

Panelius: S. Antão, Mte. Conceição, 1. 1. 54, 5 spec. under stones and in the moist vegetation at a well.

Distribution: Europe, spread over all Macaronesia.

Vitrinidae

14. *Vitrina* (*Insulivitrina*?) sp.

Dohrn: S. Antão.

Nothing can with certitude be said about this species as Dohrn's material has been lost. It is possible that we are dealing with an *Insulivitrina* Hesse, which genus has representatives in the other Macaronesian islands.

Zonitidae

15. *Oxychilus draparnaldi* Beck

Germain: *Hyalinia lucida* Drap.

Cessac: S. Vicente.

Distribution: Europe.

Germain thinks that it is probably *O. cellarium* Müller which has spread to the other Macaronesian islands.

16. *Retinella* sp.

Panelius: S. Antão, Mte. Conceição, 1. 1. 54, 1 spec. S. Nicolau, Rib. Brava, 7. 12. 53, 1 spec. Under stones.

Probably a European species.

Radula in fig. 1.

Valloniidae

17. *Vallonia pulchella* Müller

Panelius: S. Antão, Chã de Morte, 5. 1. 54. About 50 specimens among dry mango leaves on the ground together with *Gastrocopta acarus*.

Distribution: Europe, East and North Asia, North America, North Africa, Australia and Macaronesia.

Endodontidae

18. *Punctum pusillum* Lowe

Wollaston: *Patula pusilla* Lowe; Germain: *Pyramidula pusilla* Lowe

Dohrn: S. Antão, S. Vicente, S. Nicolau.

Panelius: S. Antão, Campo da Cão, 30. 12. 53, 2 adults and 7 young specimens among dry mango leaves on the ground together with *Pupilla gorgonica*.

Distribution: Macaronesia.

19. *Keraea gorgonarum* Dohrn

Wollaston: *Patula (Iulus) gorgonarum* Dohrn; Germain: *Pyramidula (Insuliula) gorgonarum* Dohrn.

Dohrn: S. Antão, S. Vicente, S. Nicolau.

Panelius: S. Nicolau, Mte. Gordo, 9 and 15. 12. 53, 3 adults and 6 young specimens in the moist vegetation in the cloud belt.

Distribution: The Cap Verde Islands.

The specimens show some variation as to the height of the shell, the convexity of the coils and the colour pattern.

20. *Keraea bouvieri* Morelet

Wollaston: *Patula (Iulus) bouvieri* Mor.; Germain: *Pyramidula (Insuliula) bouvieri* Mor.

Bouvier: S. Vicente; Lowe: S. Vicente.

Distribution: The Cap Verde Islands.

Wollaston thinks that the species is but a race of *K. gorgonarum*.

21. *Keraea bertholdiana* Dohrn

Wollaston: *Patula (Iulus) bertholdiana* Dohrn; Germain: *Pyramidula (Insuliula) bertholdiana* Dohrn.

Dohrn: S. Antão, S. Vicente.

Panelius: S. Antão, Mte. Conceição, 1. 1. 54, 13 specimens under stones.

Distribution: The Cap Verde Islands.

P u p i l l i d a e

22. *Lauria dohrni* Pfeiffer

Wollaston: *Pupa dohrni* Pfeiff.

Dohrn: S. Antão, S. Nicolau; Lowe: S. Antão, S. Nicolau; Fea: S. Antão.

Distribution: The Cap Verde Islands.

It is possible that this species is a race of *L. cylindracea* Costa from Europe, North Africa and the other Macaronesian islands.

23. *Pupilla gorgonica* Dohrn

Wollaston: *Pupa gorgonica* Dohrn

Dohrn: S. Antão, S. Vicente, S. Nicolau, S. Tiago, Fogo, Brava; Wollaston: S. Vicente, Fogo, Brava.

Panelius: S. Antão, Campo da Cão, 30. 12. 53, a great number of specimens among dry mango leaves on the ground together with *Punctum pusillum*. Pombas, 23. 12. 53, 20 spec. under stones. S. Nicolau, Mte. Gordo, 9 and 15. 12. 53. Numerous specimens under stones and on the vegetation in the cloud belt.

Distribution: The Cap Verde Islands.

Among my specimens I found all the three varieties distinguished by Dohrn: the normal form from S. Nicolau, *brevior* from Campo da Cão and *minor* from Campo da Cão and Pombas.

It is possible that this species is a race of *P. fontana* Krauss from South Africa and Ethiopia.

24. *Pupoides senegalensis* Morelet

Panelius: Brava, Rib. Vinagre, 24. 2. 54, 7 spec. from debris at the side of a brook. Vila de Nova Cintra, 22. 2. 54, 4 spec. under stones.

Distribution: Senegal and Angola.

My specimens correspond completely to Tryon-Pilsbry's pictures. It is possible that Dohrn's material of *P. gemmula* also contained *senegalensis* as his specimens partly are too great to be *gemmula*. He states that these two species are closely related, but that the Cap Verde animals differ from *senegalensis* because of their minor size. My specimens correspond however well to Pilsbry's informations about the size of *senegalensis*.

It is possible that this species is a race of *P. coenopictus* from South Asia and Arabia.

25. *Pupoides gemmula* Benson

Wollaston: *Bulimus gemmula* Bens.; Germain, Fischer-Piette: *Napaeus gemmula* Bens.

Layard: S. Vicente; Dohrn: S. Antão, S. Vicente, S. Nicolau, S. Tiago; Wollaston: S. Vicente, Fogo, Brava.

Panelius: S. Antão, Rib. Grande, 29. 12. 53, 1 spec. S. Nicolau, Rib. Brava, 7. 12. 53, 3 spec. Sal, Serra Negra, 24. 1. 54, 2 spec. Under stones.

Distribution: The Cap Verde Islands.

This species is by all earlier authors placed in the family Enidae and the genus *Napaeus*. Wollaston, however, expresses doubt as to the family and considers it possible that we are dealing with a Pupillid, but his views have not been taken for granted. The *Napaeus* species from the other Macaronesian islands probably belong to this genus and Enidae, but obviously *gemmula* has been grouped with them without proper examination. The radula (fig. 1) shows no similarity to that of the Enides, but it corresponds completely to that of *P. senegalensis* and well to Pilsbry's picture of *Pupoides radulae*. «*Napaeus*» *gemmula* evidently belongs to the family Pupillidae and the genus *Pupoides*. It differs from *senegalensis* as to its minor size and its thinner and more transparent shell. (Average length of *P. senegalensis* respectively *gemmula*: 4.92 ± 0.11 mm, 3.48 ± 0.10 mm).

It is possible that a part of the earlier collector's material consists of *P. senegalensis*.

26. *Truncatellina molecula* Dohrn

Wollaston: *Pupa molecula* Dohrn.

Dohrn: S. Antão.

Distribution: The Cap Verde Islands.

27. *Gastrocopta acarus* Benson

Wollaston: *Pupa acarus* Bens.

Layard: S. Vicente; Dohrn; S. Antão, S. Vicente, S. Nicolau, S. Tiago; Wollaston; S. Antão, S. Vicente, Fogo; Fea.

Panelius: S. Antão, Chã de Morte, 5. 1. 54. Numerous specimens among dry mango leaves on the ground together with *Vallonia pulchella*.

Distribution: The Cap Verde Islands.

Subulinidae

28. *Rumina decollata* Linne

Wollaston: *Stenogyra decollata* L.

Bouvier & Cessac: S. Antão, S. Nicolau, Boa Vista, S. Tiago.

Panelius: S. Antão, Rib. Grande 29. 12. 53, 3 spec. on a rock wall with trickling water under a banana plantation. S. Nicolau, Rib. Brava, 8. 12. 53, numerous specimens among mouldering leaves on the ground in a banana plantation.

Distribution: The Mediterranean area, spread to the coasts and islands of the Atlantic Ocean.

29. *Zootecus insularis* Ehrenburg

Wollaston: *Stenogyra subdiaphana* King.

King: S. Tiago; Dohrn: S. Nicolau, S. Tiago; Cessac: S. Nicolau, S. Tiago; Wollaston: S. Tiago, Fogo, Brava; Newton: S. Nicolau, Boa Vista, S. Tiago, Brava; Fea.

Panelius: S. Nicolau, Rib. Brava, 7-10. 12. 53, 46 spec. Sal, 18-27. 1. 54, 104 spec. Boa Vista, 29. 1-1. 2. 54, 56 spec. S. Tiago, Sta. Catarina, 11. 2. 54, 12 spec. Fogo, 16-21, 2. 54, 9 spec. Brava, 22. 2-5. 3. 54, 17 spec. Ilheus do Rombo, Ilheu Grande, 27. 2. 54, 3 spec. Ilheus do Rombo, Cima, 27. 2. 54, 4 spec.

I never saw this species in active stage except on the crest of Mte. Grande on Sal where the clouds gave moisture. It was chiefly to be found under stones on dry slopes and plateaus; in Sal there was a great many in the gravel in the dry brook beds.

Distribution: From the Cap Verde Islands and Senegambia to Egypt and Ethiopia, in South Arabia and in South Asia to Burma.

The size of this species varies from island to island. The average lengths are as follows:

S	SN	BV	ST	C	IG	F
11.12	12.14	12.14	13.32	13.40	14.40	15.44
±0.08	±0.10	±0.09	±0.19	±0.26	±0.23	±0.24 mm

The regression coefficients of the regression lines of the number of coils in relation to the length of the shell within the different populations do not differ significantly from each other; this means that the difference in length does not to a degree worth mentioning depend on variations in the height of the coils. The distribution of the average values of the different populations around the regression line of the entire Cap Verde population is greater than chance allows but not remarkably great. The differences between the average values of the different populations

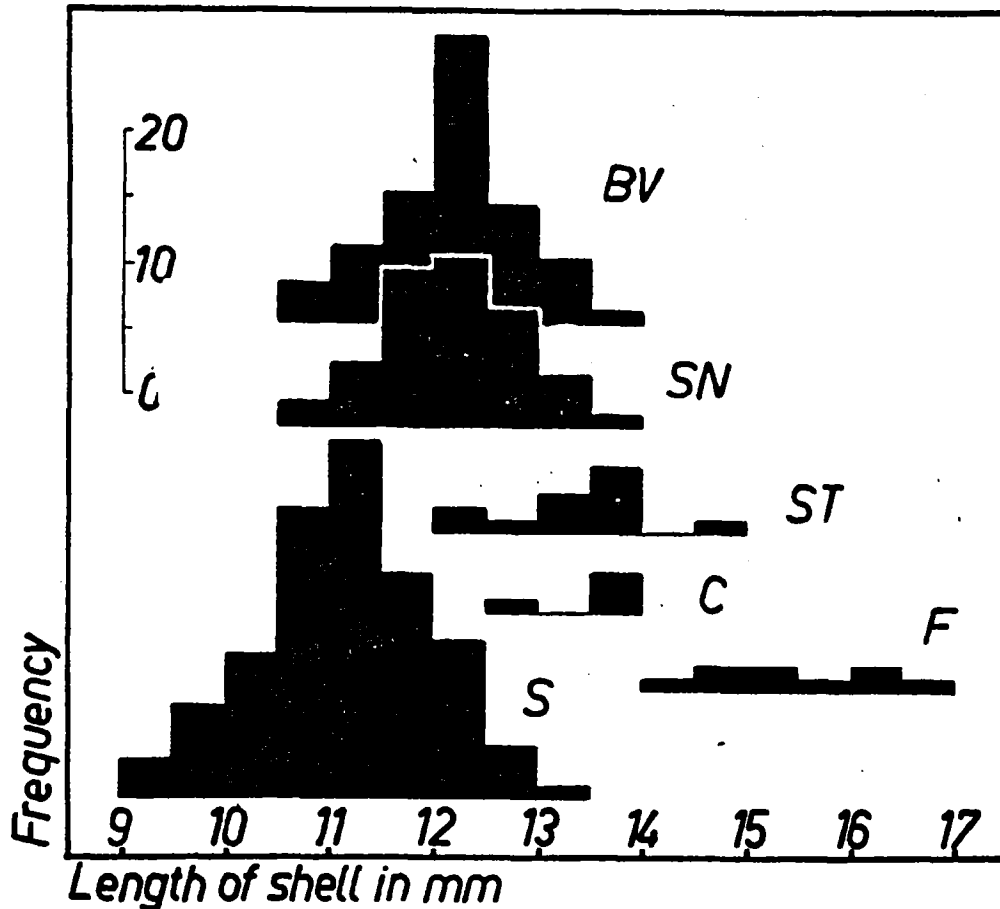


Fig. 2. *Zooteucus insularis* Ehr. Length distribution of populations from different islands.

thus chiefly depend on the growth of the number of coils and to a certain degree in differences in the height of the first coils.

The relation between the length and the width of the shell is more varying; neither the differences between the regression coefficients nor the distribution of the average values can entirely depend on chance. Thus the individual populations at least to a certain degree differ from each other concerning the width of the shell in relation to its length and the growth of its width in relation to its growth in length.

Consequently the populations in the different islands differ from one another also in other ways than in their shell-length, but the variations of this can chiefly be ascribed to the variation in the number of coils. It is impossible to say on what these variations depend, at least as long as exact informations of the biology of the species do not exist.

It seems as if the size was growing from minimum in Sal to maximum in Fogo and Ilheus do Rombo. It is difficult to say whether this growth is accidental or whether it depends on ecological or historical factors, however, it may be of interest to note that the shell-lengths of specimens from West Africa correspond to those from Sal and Boa Vista, the islands situated next to the continent.

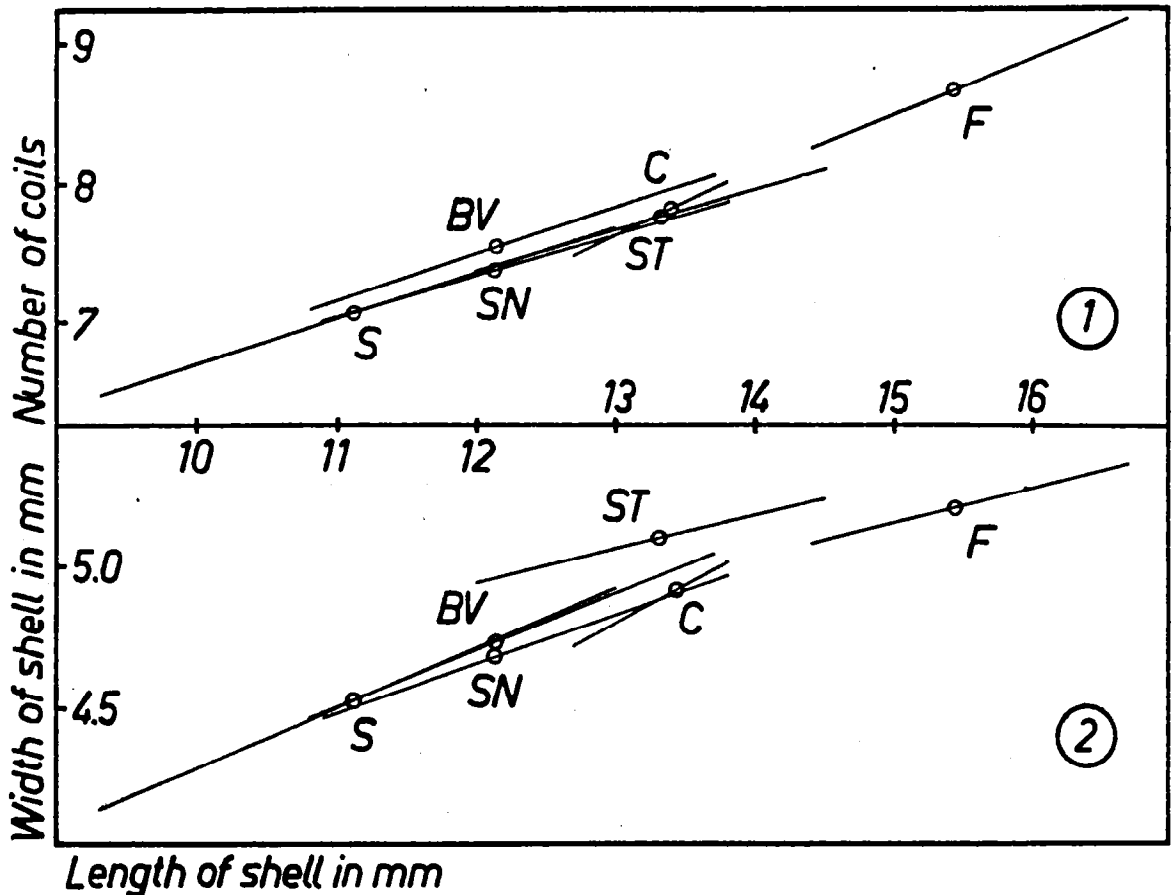


Fig. 3. *Zootecus insularis* Ehr. Regression lines for populations from different islands. 1. The number of coils in relation to the length of the shell. 2. The width of the shell in relation to its length.

The specimens from Brava cannot be treated statistically, because it is extremely difficult to distinguish between full-grown and almost full-grown animals. This difference was well developed in the other islands, but probably a new generation was reaching maturity here at the moment I made my collections.

30. *Opeas hannensis* Rang

Wollaston: *Stenogyra goodallii* Miller

Dohrn: S. Antão; Bouvier: S. Nicolau; Wollaston: S. Tiago, Brava; Fea.

Distribution: The West Indies, widely spread.

31. *Opeas greeffi*? Girard

Panelius: S. Antão, Pombas, 23. 12. 53, 15 spec. Campo da Cão, 30. 12. 53, 4 spec. Chã de Morte, 5. 1. 54, 5 spec. S. Nicolau, Rib, Brava, 7. 12. 53, 6 spec. Brava, Rib. Vinagre, 24. 2. 54, 4 spec.

32. *Opeas* sp.

Panelius: Fogo, S. Filipe, 16. 2. 54, 2 adults and one young specimen.

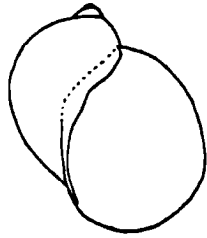
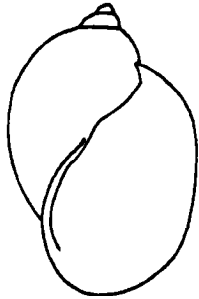
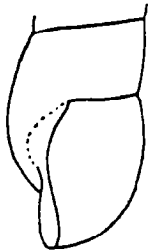
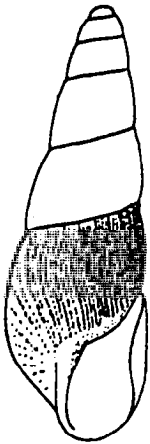
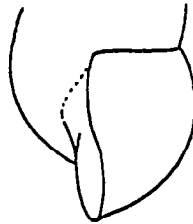
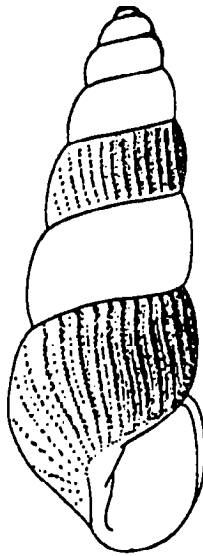
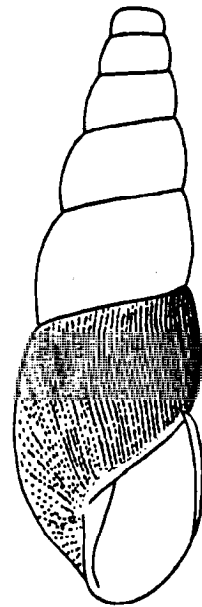
*Lymnaea natalensis**L. auricularia**Opeas sp. 33**Opeas greeffi**Opeas sp. 34**Opeas sp. 32*

Fig. 4. Magnification: *Opeas* spp. 7 X, *Lymnaea* spp. 2¼ X.

33. *Opeas* sp.

Panelius: S. Antão, Pombas, 23. 12. 53, 12 spec. Rib. Grande, 29. 12. 53, 3 spec. Campo da Cão, 30. 12. 53, 1 spec. Chã de Morte, 5. 1. 54, 1 spec. Tarrafal, 12. 3. 54, 1 spec. S. Nicolau, Rib. Brava, 7. 12. 53, 4 spec. Brava, Rib. Vinagre, 21. 2. 54, 1 spec.

34. *Opeas* sp.

Panelius: S. Antão, Tarrafal, 12. 3. 54. 2 spec. Brava, Rib. Vinagre, 24. 2. 54, 28 spec. Vila de Nova Cintra, 22. 2. 54, 111 spec.

The four last species of *Opeas* lived among mouldering plant debris on the ground and under stones in moist places.

These species differ from each other at least in the following characters:

31. Striation strongly curved, coils little convex.

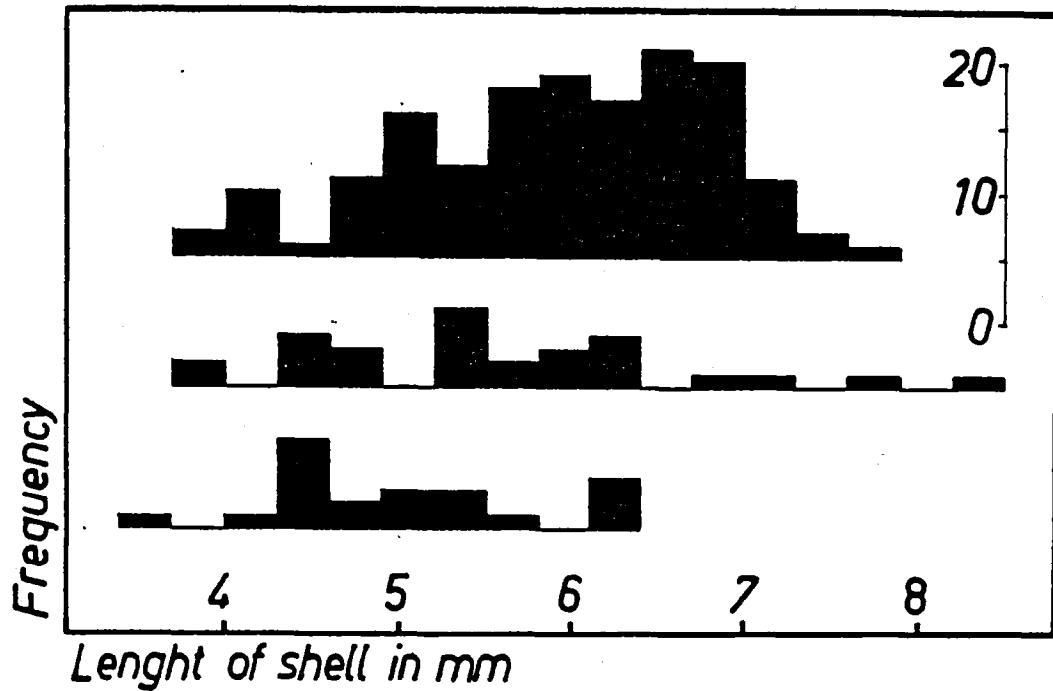


Fig. 5. Length distribution of (from above): *Opeas* sp. 34 from Brava, Vila de Nova Cintra, *Opeas* sp. 34 from Brava, Rib. Vinagre, *Opeas* sp. 33 from S. Antão, S. Nicolau and Brava.

32. Striation fine, regular, faintly curved.

33. Striation more rough and irregular, aperture smoothly rounded.

34. Striation rough, rather regular, angle between columella and lower edge of aperture.

31 corresponds very well to Germain's (1916) picture of *O. greeffi* from the islands in the Guinea Bay. 32 is well differentiated from the others. 33 and 34 remind most of each other, but there should be no difficulty in identifying also single specimens. As it is impossible to decide from the edge of the aperture of an *Opeas* whether the animal is full-grown or not it is difficult to indicate the size. It is evident that my material of 33 and 34 contains grown-ups as well as young ones, a fact indicated also by the distribution curve. (fig. 5) Grown-up specimens of 33 should have an average length of 5–6 mm, of 34 about 6.5 mm.

It is utterly difficult to decide the taxonomical value of these «species» because the systematics of the genus *Opeas* needs to be revised. Owing to the lack of comparative material it is difficult to decide whether any of my species is identical with the previously found *O. hannensis*. It seems strange that I have not found a single specimen of a species that earlier collectors have found abundantly and instead several species that have never been found before. However, none of my species corresponds to Pilsbry's picture and description of *hannensis*, neither do they correspond to Wollaston's description. This agrees only with 33, which, however, differs in one point: *hannensis* ought to have «exceedingly curved» striation whereas 33 has relatively faintly curved striation.

F e r u s s a c i i d a e

35. *Caecilloides spiculum* Benson

Wollaston: *Achatina spiculum* Bens.; Germain: *Caecilioides amaenitatum* Dohrn.

Layard: S. Vicente; Dohrn: S. Antão; Cessac: S. Antão, S. Vicente; Fea: S. Nicolau?

Distribution: The Cap Verde Islands.

H e l i c i d a e

36. *Helicella armillata* Lowe

Wollaston: *Helix (Xerophila) armillata* Lowe.

Bouvier & Cessac: S. Vicente.

Distribution: Europe, Madeira and the Azores.

37. *Helicella antoniana* Rochebrune

Cessac: S. Antão.

Distribution: The Cap Verde Islands.

38. *Caesarella lenticula* Férussac

Wollaston: *Helix (Caracollina) lenticula* Fér.; Germain: *Helicodonta lenticula* Fér.

Dohrn: S. Nicolau; Cessac: S. Vicente; Fea.

Panelius: S. Nicolau, Rib. Brava, 7. 12. 53, 2 spec. Brava, Rib. Vinagre, 24. 2. 54, 3 spec. Vila de Nova Cintra, 22. 2. 54, 12 spec. Under stones and among debris in moist places.

Distribution: The Mediterranean area and Macaronesia.

39. *Otala lactea* Müller

Cessac: S. Tiago, S. Vicente.

Distribution: The Mediterranean area, the Canary Islands and the Azores.

40. *Theba pisana* Müller

Germain: *Euparypha pisana* Müll.

Cessac: S. Antão, S. Tiago.

Distribution: The Mediterranean area, the Canary Islands and Madeira.

41. *Leptaxis subroseotincta* Wollaston

Wollaston: *Helix (Leptaxis) subroseotincta* Woll.

Lowe: Brava; Cessac: S. Tiago.

Distribution: The Cap Verde Islands.

See *L. leptostyla*.

42. *Leptaxis bollei* Albers

Wollaston: *Helix (Leptaxis) bollei* Alb.

Bolle: S. Nicolau; Dohrn: S. Vicente, S. Nicolau; Lowe: S. Nicolau; Bouvier & Cessac.

Distribution: The Cap Verde Islands.

See *L. leptostyla*.

43. *Leptaxis leptostyla* Dohrn

Wollaston: *Helix (Leptaxis) leptostyla* Dohrn.

Dohrn: S. Antão.

Distribution: The Cap Verde Islands.

Wollaston thinks that it is probable that *L. leptostyla*, *bollei* and possibly *subroseotincta* are but insular races of the same species.

44. *Leptaxis advena* Webb & Berthelot

Wollaston: *Helix (Leptaxis) advena* W & B.

Reibisch; Dohrn: S. Antão, S. Vicente; Bouvier & Cessac: S. Antão, S. Nicolau, Maio, S. Tiago (fossilized); Wollaston: S. Vicente; Cardoso: S. Antão.

Distribution: The Cap Verde Islands.

See *L. sarta*.

45. *Leptaxis sarta* Albers

Wollaston: *Helix (Leptaxis) sarta* Alb.

Bolle: S. Nicolau; Dohrn: S. Nicolau; Lowe: S. Nicolau; Cessac: S. Nicolau.

Panelius: S. Nicolau, Mte. Gordo, 9 and 15. 12. 53, 14 adults and 7 young specimens under stones in the cloud belt.

Distribution: The Cap Verde Islands.

Wollaston thinks that it is probable that *L. sarta* and *advena* are but insular races of the same species.

46. *Leptaxis visgeriana* Dohrn

Wollaston: *Helix (Leptaxis) visgeriana* Dohrn.

Dohrn: S. Tiago; Cessac: S. Tiago.

Panelius: S. Tiago, Sta. Catarina, 11. 2. 54, 16 spec. under stones.

Distribution: The Cap Verde Islands.

See *L. myristica*.

47. *Leptaxis myristica* Shuttleworth

Wollaston: *Helix (Leptaxis) myristica* Shuttl.

Shuttleworth: S. Tiago; Cessac: S. Tiago.

Distribution: The Cap Verde Islands.

Wollaston thinks that it is probable that *L. visgeriana* and *myristica* are but varieties of the same species.

48. *Leptaxis fogoensis* Dohrn

Wollaston: *Helix (Leptaxis) fogoensis* Dohrn.

Lowe: Brava; Wollaston: Fogo.

Panelius: Brava, Vila de Nova Cintra, 22. 2. 54, 1 adult and 2 young specimens under stones.

Distribution: The Cap Verde Islands.

Wollaston thinks that *L. fogoensis* and *visgeriana* are very closely related.

49. *Leptaxis atlantidea* Morelet

Wollaston: *Helix (Leptaxis) atlantidea* Mor.

Bouvier & Cessac: Sal, S. Tiago.

Distribution: The Cap Verde Islands.

Fossil.

50. *Leptaxis primaeva* Morelet

Wollaston: *Helix (Cryptaxis) primaeva* Mor.

Bouvier & Cessac: Sal, S. Tiago.

Distribution: The Cap Verde Islands.

Fossil.

Additionally to these 50 species 5 more have been reported from the Cap Verde Islands. I have excluded them owing to the following reasons:

Carychium minus Férussac. Férussac mentions four species from S. Tiago, Praia, this one among them. According to several reasons Dohrn rejects all four of them; *Carychium*, however, appears anew with Morelet and is then mentioned by all succeeding authors.

Morelet neither mentions by whom nor in which island the species has been found, he probably relies on Férussac's informations.

Wollaston stresses that he, as Férussac's article is unreliable, doubts the occurrence of this species in the Cap Verde Islands, except when Morelet's informations are based on discoveries by Bouvier & Cessac.

Rochebrune remarks that the museum in Paris does not have any specimens of this species from the Cap Verde Islands.

Germain commentates: «not refund».

Fischer-Piette does not mention this species.

As no explorer after Férussac has found this species, and his informations are regarded as less reliable, I do not see any reason to consider *Carychium minus* a member of the fauna of the Cap Verde Islands.

Amphibulima tigrina Leseur. Rochebrune includes this species in his list because the museum in Paris has it in its collections with a note that it is collected in S. Vicente, the Cap Verde Islands.

Germain states: «not refund, probably wrong locality».

Fischer-Piette does not mention this species.

As several explorers have searched S. Vicente without finding *Amphibulima tigrina* it is probable that the note of the locality is incorrect.

Leptaxis corneovirens Pfeiffer. Pfeiffer reports this species from the Cap Verde Islands referring to a collection of Cuming. In «Monographia Heliceorum» he also gives New South Wales in Australia as finding locality.

Dohrn doubts the correctness of the locality information.

Wollaston states that either the Australian or the Cap Verde information must be incorrect.

Germain states that the species really is *Thersites corneovirens* from Australia.

Fischer-Piette does not mention the separate *Leptaxis* species.

It is evident that we are dealing with an Australian species which has got a Cap Verde label by mistake.

Cochlicopa lubrica Müller and *Cochlicella ventricosa* Drap. Morelet mentions both species without informing by whom or in which island they have been found.

Wollaston criticizes Morelet's method to introduce new species without exact informations, but he adds that he would not be astonished if these species were to be found also in the Cap Verde Islands.

Rochebrune tells that it is Bouvier & Cessac who found this species, and he informs about both of them «commune dans tout l'archipel».

Germain quotes Rochebrune.

Fischer-Piette mentions that both species have been found in the Cap Verde Islands.

Thus Bouvier & Cessac are the only ones to have found these two species and they could state that they were common throughout the archipelago.

It is a very remarkable fact that neither Dohrn, who made his collections five years earlier, nor Wollaston, who visited the islands four years earlier, found a single specimen of these species. Neither were any of the explorers who later during the nineteenth century made collections in the islands able to find them; it is the same with me, though I visited all the islands except the two scantiest.

Considering the bad connections between the islands I cannot imagine that these two species during a period of 4—5 years possibly could have been introduced and spread throughout «tout l'archipel». That for instance Dohrn, who has found all the Pupillides which have a way of living similar to that of the *Cochlicopa* would have overlooked this species seems to me equally impossible. It is also improbable that species which are common throughout an entire archipelago would disappear in less than a century, during which time moreover no ecological changes worth mentioning have occurred.

I cannot avoid thinking that Bouvier's and Cessac's informations entirely or partly must be incorrect. In any case it must be a mistake that the species have been found all over the archipelago. In case they have been found only in some island it is difficult to understand how an information of their existence in all has originated. I find it most probable that we have to do with a confounding of locality; the material is collected elsewhere but has been incorrectly labeled. We can scarcely get any certainty in this question, but it is evident that Bouvier's and Cessac's informations are not quite reliable.

A list of species can contain either all species that have been reported from the district in question and which are not proved to have been mentioned according to wrong informations, or all the species which have been proved to have been found in the district. I consider that a list which is to be used as a basis for animal geographical reasoning should be of the latter type, and that is why I exclude *Cochlicella ventricosa* and *Cochlicopa lubrica*.

THE ORIGIN OF THE FAUNA

As we have to do with a region which like the Cap Verde Islands only has been sporadically searched it is often difficult to state whether a species has been introduced with man or whether it has arrived by means of »natural» manners of spreading. Therefore it is probable that further studies to some degree will change the following classification, though hardly concerning the endemites.

Freshwater species. The freshwater fauna differs so much from the land fauna as to its composition that I prefer to treat it separately following the example of Fischer-Piette.

Hydrobia ventrosa, which is a common European species, is most probably introduced with man, and the same can be said about the other *Hydrobia*, for otherwise it is difficult to understand how it could have reached such a biotop influenced by culture as a saline pond in an island most probably missing constant natural ponds. Of the *Lymnaea* species *natalensis* is probably introduced from West Africa; *auricularia* probably derives from the Iberian Peninsula and has arrived with the colonists. It is, however, more probable that, if a radula structure such as that of the Cap Verde specimens does not exist elsewhere, it has immigrated already before the colonisation. *Melanoides* and *Physa* are common African species, and it is quite probable that they have spread with for instance water-birds, but it is impossible to say anything definite. *Melanoides* seems to be dependent on culture and this makes it more probable that it has been introduced with man; a contradicting fact is that it has developed races, an indication that it has existed in the islands for a fairly long time.

As to *Gyraulus* one cannot say anything because it has not been determined as to its species. *Ancylus milleri* is endemic to the Cap Verde Islands and it is consequently the only species which without doubt has immigrated before the colonisation.

The freshwater fauna is remarkably poorer than the land fauna, the African influence being stronger (at least 3/8) and the endemic weaker. Germain considers that it is not of African origin (what I can see there is, however, no stronger reason to consider it of European or Macaronesian origin) and that the pooriness would be explained if the islands were pieces of a broken continent where desert climate was prevailing at the time of their origin. The correctness of the latter statement, however, is doubted by Fischer-Piette.

It seems possible to me to explain the poorness of species as well as the composition of the fauna thus: the islands are small, steep, volcanic and they have in any case now a very dry climate. If we suppose that they at their origin had or relatively rapidly got a freshwater fauna it is not very probable that it could have persisted until our days, because running water in steep regions is exposed to great changes, because streams occasionally may have been ruined by volcanic eruptions, because the spreading is difficult in regions where no water-birds hatch and because the climate has become drier owing to the destruction of the forests some centuries ago. The land fauna has entirely different possibilities to survive. During the whole time the islands have existed freshwater molluscs have immigrated, but they have never been able to survive for a longer period. If this theory is correct we can understand that there are few endemic species and that the fauna is poor and originates from Africa and South Europe, which are the regions where the flight of migrating birds over the Cap Verde Islands reaches the continents. We can also expect that the only endemite is to be found in the island, S. Tiago, which has the greatest area.

Land species introduced with man. *Deroceras agreste* and *Milax gagates* are two species that have proved to have a great capacity of spreading; that they have immigrated recently is shown by the fact that Dohrn is the only one of my predecessors who has found Limacidae, probably *Deroceras*, which now has the greater extension within the archipelago and therefore probably has arrived earlier.

Oxychilus draparnaldi, *Vallonia pulchella*, *Helicella armillata* and *Caesarella lenticula* are all common European species which are known to be spread with man, and it is therefore probable that they have arrived in that way, especially *Vallonia* which has not been found before. That is probably also the case with the *Retinella* species.

Opeas has a very great capacity of spreading, none of my four species has been found earlier and it is less probable that *hannensis* would have immigrated from the West Indies without the help of man; thus it should be evident that the representatives of this genus in the Cap Verde Islands do not belong to the original fauna.

Rumina decollata and *Pomatias elegans* are European species of which at least *Rumina* seems to be dependent on culture in the Cap Verde Islands, whereas *Pomatias* has not been refound and perhaps has been an occasional guest. However, Cessac states that he has found both species fossilized; this is doubted by Germain who supposes that shells of dead

animals occasionally have been mixed with disintegrated sediments. The fact that neither Dohrn nor Wollaston have found the great *Rumina* suggests that it is recently introduced, as to *Pomatias* the case is still more doubtful.

Otala lactea and *Theba pisana* have been found by Cessac only; they have evidently been occasional guests unable to acclimatize themselves.

As *Pupoides senegalensis* has not been found by the earlier explorers it is probable that it has been introduced recently.

Species of doubtful origin and nonendemics which have immigrated before the colonisation. *Punctum pusillum* is a Macaronesian endemite and thus it perhaps belongs to the original fauna of the Cap Verde Islands, but it is also possible that it has been introduced with man.

As it has been impossible to determine the species of Dohrn's *Vitrina* we cannot say anything certain about it; it may be an introduced European species, but it may also be a Cap Verde representative of the in Macaronesia endemic genus *Insulivitrina*.

Zootecus insularis has evidently existed in the Cap Verde Islands for a long time as it has developed different races; yet we are dealing with the same species as in Africa.

Endemic species. The following are related to the Mediterranean and European species: *Succinea lowei*, *Lauria dohrni*, *Truncatellina molecula*, *Caecilioides spiculum*, *Helicella antoniana*.

The following are related to African species: *Quickia wollastoni*, *Pupilla gorgonica*, *Pupoides gemmula*.

Related to American species is: *Gastrocopta acarus*.

Endemic Macaronesian are the genera *Keraea* and *Leptaxis*.

Of these *Lauria dohrni*, *Quickia wollastoni* and *Pupilla gorgonica* are possibly but endemic races of European or African species. Some of the *Keraea* and *Leptaxis* species are probably but insular races.

It is evident that an endemic species must have been isolated for a long time. If a species has developed an endemic race it is probable that the isolation has operated for a shorter time, but this is naturally not certain: there is no law according to which differentiation must go on equally rapidly with all species. It is possible that the above mentioned races and *Zootecus* have existed in the Cap Verde Islands as long as the endemic species, and it is also possible that the fainter differentiation means that they have immigrated later. In any case it is evident that they

have become members of the fauna in the islands long before colonisation and they thus are a part of the indigenous fauna.

The composition of the land fauna is consequently as follows (the *Keraea* species have been reduced to 2 and the *Leptaxis* species to 6):

	Intro- duced with man	Of doubt- ful origin	Indigenous				
			Total	Doubtful species treated as species		Doubtful species treated as races	
				Non- ende- mic	Ende- mic	Non- ende- mic	Ende- mic
European	10	—	5	—	5	1	4
African	2	—	4	1	3	3	1
American	1	—	1	—	1	—	1
Macaronesian	—	1	8	—	8	—	8
Of uncertain origin	4	1	—	—	—	—	—
Total	17	2	18	1	17	4	14

It is obvious that the fauna is clearly dominated by endemites and by species introduced by man, and this means that the original fauna of the island was almost wholly endemic. Of these original species, 8 are of Macaronesian origin, 5 of European and 4 of African; as we have to do with comparatively small numbers, we cannot make any other conclusions than that the Macaronesian influence is dominating and that it is not certain that the African influence is weaker than the European. Germain and Fisher-Piette have an other opinion, they think that the European influence is quite dominating compared to the African, and that there is only one African species, *Zootecus*. I cannot see the authorization of this opinion, because omitting the endemic species and their relations, we must state that there also is only one European species (the number can be somewhat raised if we maintain that some of the species I have presumed to be introduced with man actually belong to the original ones). If we count the endemic species we get the numbers mentioned above. On the contrary I quite agree with Germain that the fauna is characterized by the Macaronesian genera.

THE FAUNA OF THE CAP VERDE ISLANDS IN RELATION TO THAT OF THE
OTHER MACARONESIAN GROUPS OF ISLANDS.

Fisher-Piette points out that the fauna of the Cap Verde in spite of the southern situation of the islands and their proximity to the African coast does not differ from that of the other groups of islands: the Mediterranean and the Macaronesian influence dominates while the African one is not noticeable. As I said above, I cannot completely agree with him, of the 42 land species in the Cap Verde Islands four are undoubtedly of African origin, may it be that they only would represent geographical races of African species. As far as I know, the Canarian Islands are the only ones of the other groups of islands that have African representatives: *Webbia dealbata* and *Zootecus*. Whatever our opinion of the importance of the African influence in the Cap Verde Islands compared to the European may be, we must state that the fauna of the Cap Verde Islands of the Macaronesian groups of islands is the one with the strongest African influence.

Concerning mutual species and genera we can state as follows: The Cap Verde Islands have only one species in common with the other groups of islands, that is *Punctum pusillum*, and it is doubtful whether it has been spread without the help of man. In this respect the Cap Verde Islands are practically isolated from the other groups of islands, which all have from 4 to 7 species in common. Speaking of genera we find that of the 15 original genera in the Cap Verde Islands 10 are common with other groups of islands. However, this is not of such great interest as the greater part of these genera also exist on the continents and thus they need not suggest any connection between the groups of islands. There are, however, 8 genera which are endemic to Macaronesia, 2 or possibly 3 of them occur in the Cap Verde Islands.

	The Azores	Madeira	The Canary Islands	The Cap Verde Islands
Hemicycla			×	
Webbia			×	
Geomitra		×		
Staurodon		×		
Insulivitrina	×	×	×	?
Keraea		×	×	×
Leptaxis	×	×	×	×
Craspedopoma	×	×	×	

The four latter genera are in a special position as they form a Macaronesian »fonds commune». As to genera the Cap Verde Islands without doubt belong to Macaronesia, but they are still to a certain degree isolated in relation to the others, which fact is further stressed by the total lack of common species. The centrally situated Canary Islands and Madeira seem to possess the greater part of the endemic Macaronesian fauna.

The relation between European, Macaronesian (for the Cap Verde Islands also African) and endemic species in the different groups of islands may also be of interest. The following list of this distribution among the land species is based on Wollaston except for the Cap Verde Islands. As his concept of species may be doubtful, there is some uncertainty, especially concerning the Canary Islands.

	The Azores	Madeira	The Canary Islands	The Cap Verde Islands
Introduced	26	25	16	18
Macaronesian	8	7	9	2
Endemic	33	131	152	22
Total	67	163	177	42

It is striking that the number of introduced species is about the same in all groups of islands, and that is why the different numbers of percentage of endemism that we get when we take the endemites in relation to all species probably has a fairly small importance and is almost proportional to the total number of species. At the time of the discovery of the islands probably from 90 to 95% of the fauna was endemic possibly excepting the Azores. Considering the affinities of the endemites we can state that the fauna of the Canary Islands to a higher degree than that of the other islands reminds of the Mediterranean fauna.

The freshwater faunas are like that of the Cap Verde Islands. They consist to the greater part of European, probably recently introduced species, eventually there are endemites, but in order to decide that question a more solid investigation should be made. Still the African influence is missing. The faunas are poor compared to the land faunas.

As a summary we can characterize the fauna of the Cap Verde Islands in relation to the other Macaronesian faunas thus:

1. The fauna is dominated by the European-Macaronesian influence, but the African influence is stronger than in any other group of islands.

2. The fauna shows obvious Macaronesian features, but less pronounced than in the other groups of islands.

3. The original species are dominated by the endemites, probably to as high a degree as in the other groups of islands.

THE HISTORY OF THE FAUNA

We do not get any apprehension of the development of the Cap Verde fauna on the basis of the fossiles that have been found in the islands in sediments from the late Tertiary or eventually from the beginning of the Quaternary period. Three *Leptaxis* species: have been found there *primaeva*, *atlantides* and *myristica*, *Zooteus insularis*, *Rumina decollata* and *Pomatias elegans*. The question of the fossilization of the two latter species has been treated before, concerning *Zootecus* it is possible that it has belonged to the fauna already in the late tertiary but it also possible that the case is the same as that of *Pomatias* and *Rumina*.

We can see obvious connections with the European tertiary fauna. According to Germain *Leptaxis* derives from *Helicides* from East European oligocene; from Central European miocene we know a species of the subgenus *Pseudocampylea* which can still be found in Madeira. *Pupilla gorgonica* shows great similarity to *Pupillides* from Central European oligocene and miocene. Also other Macaronesian genera and species show similarities to miocene European.

Most varying theories about origin of the Macaronesian islands and their history have been presented, all from that of Cockerell that the islands are purely oceanic to that of Germain that they are the remains of a broken Atlantic continent. My conception may be summed up in the following four points:

1. It is difficult to deny that the Macaronesian groups of islands have had some kind of communication with each another, as their faunas show such a great mutual similarity and as they are so distinct from these of the surrounding continents.

2. As we take into consideration the obviously enormous difficulties of the spreading it seems utterly improbable that they should always have been islands and that the similarities would depend on the fact that the same, on the continents during the tertiary period common but later extinct species, would have spread to the different groups of islands. The distance between Madeira and Porto Santo in the Madeira group is about 50 km, nevertheless only 5 (of which 2 probably are introduced

with man) of the 77 *Helicides* on these two islands are mutual to both of them. The distances between the separate groups of islands amount to at least ten times as much.

3. Geological facts suggest that the Cap Verde Islands have been connected with Africa during miocene, a matter that agrees well with the similarity of the recent fauna with the European fauna of this period.

4. The similarity to the faunas of the other Macaronesian groups of islands does not necessarily mean that the islands have been directly connected with each other. Because of geological reasons we think that during miocene the Canary Islands and Madeira have been connected with North Africa resp. the Iberian Peninsula, which in their turn have been connected across Gibraltar. The European-North African fauna of this period reminded of the recent Macaronesian and was spread over areas which now are islands. When these were isolated the fauna survived on them but was destroyed or changed on the continents. Under these circumstances it is possible to explain that the same features reappear in the different Macaronesian islands whereas we miss them on the continents.

REFERENCES

- ADAM, W., 1947. *Mém. Mus. Roy. D'Hist. Nat. Belg.*, 106, Bruxelles.
- ALBERS, I.-C., 1854. *Malak. Blätt.*, p. 213—221, Cassel.
- BENSON, 1856. *Ann. Mag. Nat. Hist.*, 2: XVIII, London.
- BOURCART, J., 1946. *Soc. Biogeogr., Mém. VIII*, Paris.
- CHEVALIER, A., 1935. *Rev. Bot. Appl. D'Agr. Trop.*, XV, Paris.
- DOHRN, H., 1869. *Malak. Blätt.*, p. 1—23, Cassel.
- EHRMANN, P., 1932. *Tierwelt Mitteleuropas*, 2, Leipzig.
- FISCHER-PIETTE, E., 1946. *Soc. Biogeogr., Mém. VIII*, Paris.
- GERMAIN, L., 1916. *Ann. Mus. Civ. Stor. Nat. Gen.*, 3: VII (XLVII), Genova.
- GERMAIN, L., 1927. *C. R. Congr. Soc. Sav.*, Paris.
- HESSE, P. F. W., 1923. *Arch. Molluskenkunde*, 55, Frankfurt a. M.
- HUBENDICK, B., 1951. *Kungl. Sv. Vet.-Akad. Handl.*, 4: 3,1, Stockholm.
- JEANNEL, R., 1946. *Soc. Biogeogr., Mém. VIII*, Paris.
- KING & BRODERIP, 1831. *Zool. Journ.*, V, London.
- MARTINI-CHEMNITZ, 1874. *Systematisches Conchylien-Cabinet*, Nürnberg.
- MENKE, 1853. *Zeitschr. Malak.*, p. 67—82, Cassel.
- MORELET, A., 1873. *Journ. Conch.*, 3: XIII (XXI), Paris.
- MOUSSON, A., 1873. *Nouv. Mém. Soc. Helv. Scienc. Nat.*, XXV, Zürich.
- NOBRE, A., 1909. *Bull. Soc. Port. Sci. Nat.*, III:2, Lisbonne.
- ODENER, N. H., 1932. *Ark. Zool.*, 23 A:14, Stockholm.
- PFEIFFER, L., 1852. *Zeitschr. Malak.*, p. 10—16, 25—29, Cassel.
- PILSBRY, H. A., 1939—48. *Acad. Nat. Sci. Phil.*, Mon. 3, Philadelphia.
- REIBISCH, TH., 1865. *Malak. Blätt.*, p. 125—133, Cassel.
- ROCHEBRUNE, A. T., 1881. *Nouv. Arch. Mus.*, 2:IV, Paris.
- ROUCH, J., 1946. *Soc. Biogeogr., Mém. VIII*, Paris.
- SHUTTLEWORTH, R. J., 1852. *Mitth. Nat. Ges.*, p. 292, Bern.
- TRYON-PILSBRY, *Manual of Conchology*, Philadelphia.
- WOLLASTON, T. V., 1878. *Testacea Atlantica*, London.