

# SINISTREXCISA, A NEW GENUS OF LAND SNAIL FROM CENTRAL WEST AFRICA WITH FOUR NEW SPECIES (GASTROPODA: PULMONATA: STREPTAXIDAE)

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## ABSTRACT

A new genus of Streptaxidae with four new species is described from Central West Africa, viz. *Sinistrex-cisa cameruniae* (type species) from Southwest Cameroon, and *S. iradierei*, *S. cogoensis* and *S. fang* from Equatorial Guinea. In addition to the shells, the genital anatomy of three species and the radula of one species are described. The species of *Sinistrex-cisa* resemble some taxa of the heterogeneous genus *Ptychotrema s.l.*, but differ conchologically by, among others, the extremely long and displaced apertural sinus and the sinistrally coiled last quarter whorl, and anatomically by the morphology of the penis, especially the inner spinulation. A spermatophore was observed in the lower (distal) portion of the penis of a specimen of *S. fang*. This is probably the first record of a spermatophore in the family Streptaxidae.

## INTRODUCTION

The history of biology shows that new discoveries are often made simultaneously by independent workers. During recent fieldwork in South-western Cameroon by AJW, and in Equatorial Guinea by BJG and CEP, the authors came across specimens of a rather peculiar taxon of the family Streptaxidae which originally each intended to describe separately. Independently we consulted Dr. B. Verdcourt, who informed us of each other's activities, and encouraged us to write a joint paper.

Many species in the carnivorous land snail family Streptaxidae have attractive shells exhibiting a wealth of characters for species identification. The supraspecific taxonomy of the family is also largely based on the shell morphology, especially the configuration of the apertural barriers. Although several workers have acknowledged that the taxonomy, especially of the genera and subgenera of the

subfamily Enneinae, is unsatisfactory due to homoplasy (e.g. Adam & Van Goethem, 1978; Van Bruggen, 1989; Verdcourt, 1990), so far little progress has been made, largely due to the rather imperfect knowledge of the morphology of the soft parts. Verdcourt (1990) provided an overview of the anatomical knowledge of the species of the Enneinae.

In the last two or three decades very few new supraspecific taxa of Streptaxidae have been introduced. Most recent papers dealt with the evaluation of named taxa and the description of new species (e.g. Adam, Van Bruggen & Van Goethem, 1993, 1994, 1995; Van Bruggen, 1989; De Winter, 1996). Since our specimens do not fit satisfactorily into any of the (sub)genera recognised to date, and constitute an obviously independent radiation, we decided to erect a new genus, but only after quite some hesitation and consultation of colleagues. From the onset it was clear that we had at least two different species, but study of the genitalia revealed that there were two additional ones.

The following abbreviations are used: MCNA, Museo de Ciencias Naturales de Alava, Vitoria-Gasteiz; MNCN, Museo Nacional de Ciencias Naturales, Madrid; RMNH, National Natuurhistorisch Museum, Leiden (Formerly Rijksmuseum van Natuurlijke Historie).

## TAXONOMIC DESCRIPTIONS

### *Sinistrex-cisa* new genus

*Diagnosis.* A taxon of the subfamily Enneinae with an elongate (sub)cylindrical to ovoid shell, which is dextral apart from the detached and sinistrally coiled last quarter whorl. The upper portion of the detached part of the last whorl, including the sinus, rests on the more strongly

sinistrally coiled lower portion. Sinus extremely long, running from the angular-palatal corner above the angular lamella to the left (front view), well outside the normal position of the aperture, with terminally one or two small (sub) circular dilatations. The columellar, palatal and basal walls of the peristome are each provided with a single external furrow, corresponding to a columellar, palatal and basal lamella inside the aperture, respectively. In the penis a sequence of three different portions can be distinguished, the central one with numerous small and medium-sized spines, as well as 5–7 much larger spines arranged around the penial lumen.

*Type species.* *Sinistrexcis cameruniae* new species.

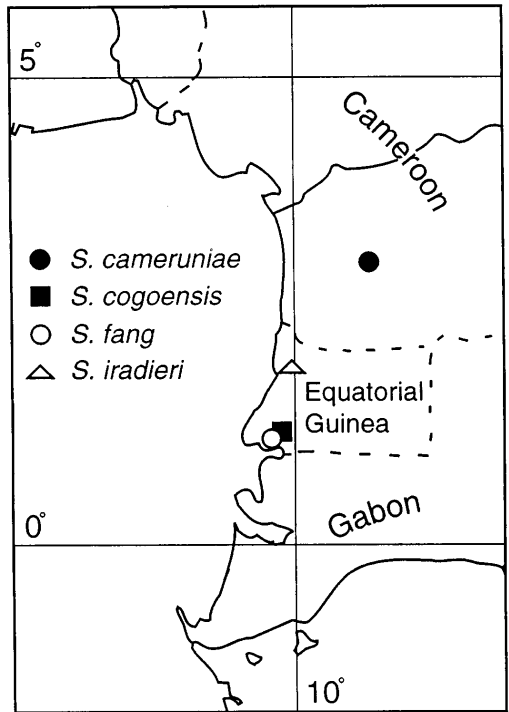
*Distribution.* So far only known from five localities in southwest Cameroon and Equatorial Guinea within a linear distance of 250 km (Fig. 1).

*Derivatio nominis.* The name is a combination of the (sub)generic name *Excisa* and the recently introduced term *sinistroid* (Gittenberger, 1995). Gender feminine.

#### *Sinistrexcis cameruniae* new species

*Material* (Fig. 1). Cameroon, Sud province, about 6 km NE. of Ebom-I, 15 km S. of Lolodorf, c. 3°06'N 10°44'E, taken from three sites within 500 m distance, alt. 430–470 m asl., A.J. de Winter & E.-J. Semengue leg., April 1996, RMNH 57257 holotype shell, RMNH 57258/1 paratype shell, RMNH alc. 9448–9450/3 paratypes in alcohol, MCNA 7001/1 paratype shell, MNCN 15.05–27825/1 paratype shell (broken to remove soft parts, but last whorl and upper 4 whorls preserved) and slide with genitalia).

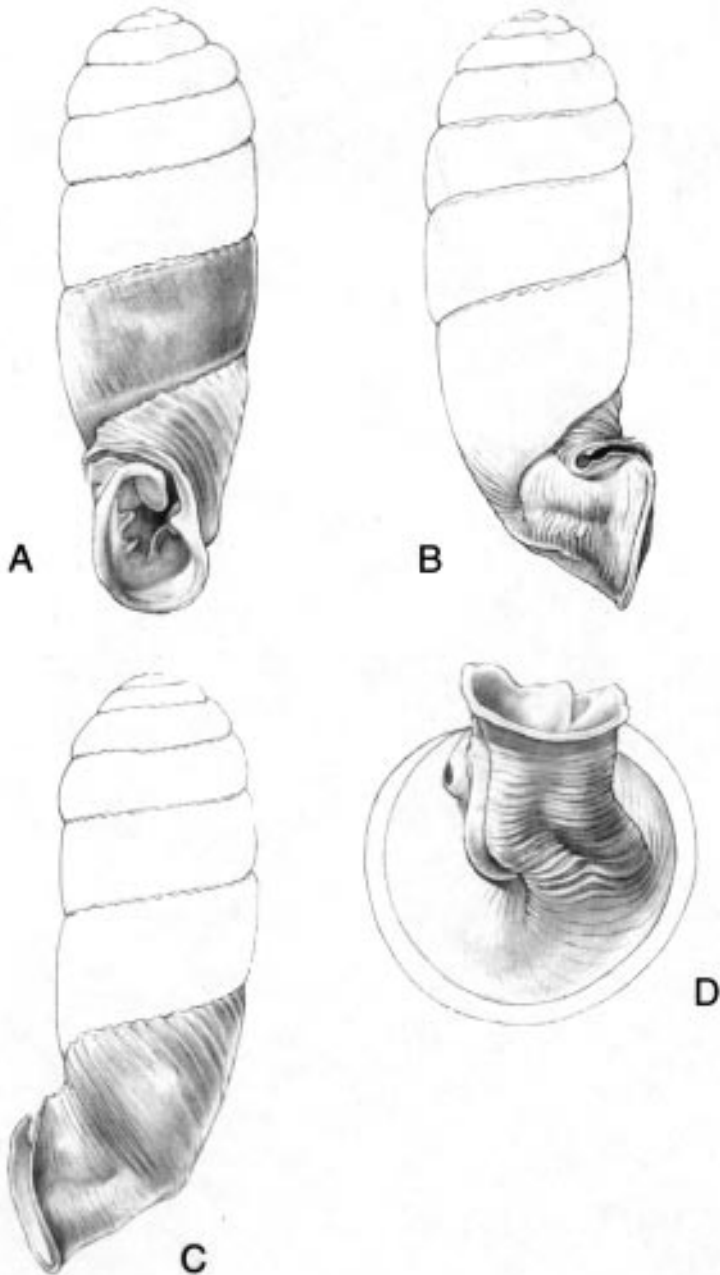
*Shell* (Figs 2A–D). Holotype: height 6.5, width 2.4 mm. Paratypes: height 6.6–7.1 mm, diameter 2.2–2.6 mm, H:D ratio 2.7–3.1. Spire elongate cylindrical, partly transparent when fresh, whitish in older shells, shining with a silky lustre. Umbilicus closed. Whorls c. 6 3/4, rather flat. Embryonic whorls not clearly separated from the later ones. About the first quarter whorl smooth, the later whorls incised by very fine, close-set, slightly sinuous and oblique axial grooves extending over the entire whorl. Suture crenulate. On about the last half whorl, and especially on the detached portion, the



**Figure 1.** Geographic distribution of *Sinistrexcis* species.

crenulations extend into more regular, distant ribs superimposed on the above described grooves. Interstices wider than ribs. The sculpture resembles that found in the otherwise very different taxa *Gulella bolocoensis* Ortiz de Zárate & Ortiz de Zárate, 1955, and *G. germaini* Connolly, 1929 (De Winter, in prep.).

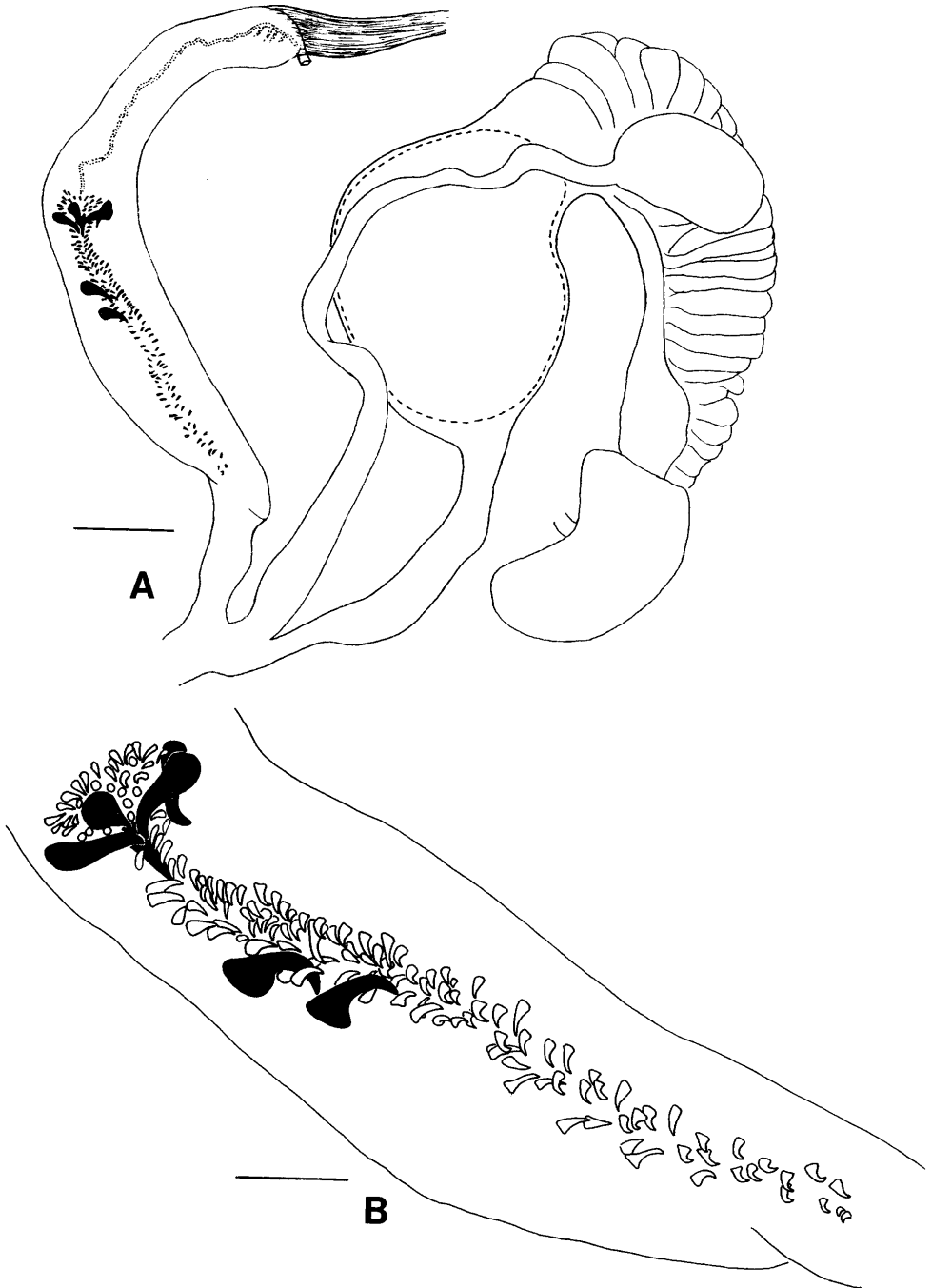
Peristome reflected. Aperture pyriform, obstructed by a complicated pattern of apertural barriers. Hind part of sinus with somewhat undulating or bluntly toothed margins, forming a well-defined circular terminal hole and a more elongate, less clearly defined, second one. Hind part of sinus somewhat bending downward relative to the rest of the sinus canal. Angular lamella high and prominent, deeply inrunning, forming the left lower margin of the sinus canal at the outlet of the sinus into the aperture. Palatal margin slightly concave, with a strong, subacute tooth which leaves the palatal lamella exposed. The curved palatal lamella corresponds to a single superficial external furrow at the concave detached part of the body whorl. Palato-basal corner expanding to the right. Basal wall with an inrunning, high



**Figure 2.** *Sinistrexcis cameruniae* new species. Holotype shell. **A.** front view. **B–C.** lateral views. **D.** umbilical view. Actual shell height 6.5 mm.

lamella rather deep inside the aperture, corresponding externally to an elongate depression. Columellar margin in lateral view obliquely positioned relative to the coiling axis. Columellar side of aperture with three folds, none of

which reach the peristome. Upper and lower columellar folds short; the larger central one corresponds to a distinct external furrow. Columellar furrow extending beyond the end of the sinus canal.



**Figure 3.** *Sinistrexisa cameruniae* new species. Paratype. **A.** Genital system; scale bar 0.5 mm. **B.** Central portion of penis, showing arrangement of spines; scale bar = 0.2 mm.

*Animal.* Soft parts of the live animal pale cream, without the bright red, green or yellow colour often observed in Streptaxidae.

*Genital system* (Figs 3A–B). Penis c. 3.9 mm long, consisting of three different portions. Proximal portion narrow and cylindrical (1.2 × 0.3 mm), devoid of spines, with a thick, muscular wall. Central portion somewhat wider (2.1 × 0.5 mm), tapering distally, with a rather thick, muscular wall, the lumen along its entire length lined by numerous, c. 50 µm long, more or less curved spines. In addition, there are seven much larger spines (c. 200 µm long), five of which circularly arranged in the upper part, the other two located more distally. Distal portion of the penis comparatively short, narrow (0.6 × 0.2 mm) and thin-walled. Vas deferens enters the penis terminally, the point of entry being obscured by dense fibres of the penial retractor muscle. Atrium small. Vagina virtually absent. Pedunculus long (3.8 mm), widest distally. Bursa copulatrix oval. The oviduct contained one large, roundish egg (c. 1.4 × 1 mm), covered by a capsule consisting of a mosaic of small quadrangular crystals.

*Ecology.* The species was found among leaf litter on the floor of an undisturbed patch of rainforest with occasional rock (gneiss) outcrops. Further details on this site are provided elsewhere (De Winter and Gittenberger, 1998).

#### *Sinistrexcis iradieri* new species

*Material* (Fig. 1). Equatorial Guinea, Machinda, 20 km W. of Bata, 1°52'45"N 9°57'30"E, 22.VIII.1993, B. Gomez leg., MCNA 7002/holotype, MCNA 7003–7005/3 paratypes, RMNH 57259/1 paratype, MNCN 15.05–27826/1 paratype (all empty shells).

*Shell* (Figs 4A–C). Holotype: height 5.5 mm, diameter 2.1 mm. Paratypes: height 5.35–5.8 mm. H:D ratio 2.6–2.9. Spire elongate ovoid, transparent, colourless or pale brown when fresh, opaque whitish in older shells, shining with a silky lustre. Whorls c. 6 1/2, clearly convex. Embryonic whorls not clearly separated from the later whorls. Shell, including the embryonic whorls, incised by very fine, close-set, slightly sinuous, oblique axial grooves. From the third whorl onwards, there are widely spaced, almost straight ribs, prominent near the suture where they originate, but gradually fading downwards to disappear at the centre of

the whorl. Interstices wider than ribs. Only on the last half whorl, including the detached portion, do the ribs extend along the entire whorl.

Peristome reflected. Aperture auriculiform, obstructed by several plicae and lamellae. End of the narrow sinus enlarged into two small (sub)circular dilatations, constituted by two facing tooth-like expansions of the sinus wall. When leaving the aperture, the sinus curves upward to the left (in front view) after which the terminal portion with the 'breathing holes' bends downwards again. Palatal wall markedly concave, columellar and basal walls rounded. Palato-basal corner expanded to the right. Palatal wall with a rounded tooth near the peristome, and a long, curved, medium high lamella underneath this tooth, with a corresponding external furrow at the concave detached part of the body whorl; this lamella ends into the inner lower part of the palatal tooth. Angular lamella high and prominent, deeply inrunning, forming the left lower margin of the sinus canal. Basal wall with a deeply situated, inrunning, rather high lamella, corresponding to an external furrow. The basal and palatal lamellas form a channel into the palato-basal expansion of the peristome. Columellar wall with three folds, converging to each other towards the peristome, but not reaching it. The short lower columellar fold originates near the start of the basal lamella; the central fold is longer and corresponds to an elongate external depression.

*Anatomy.* Unknown.

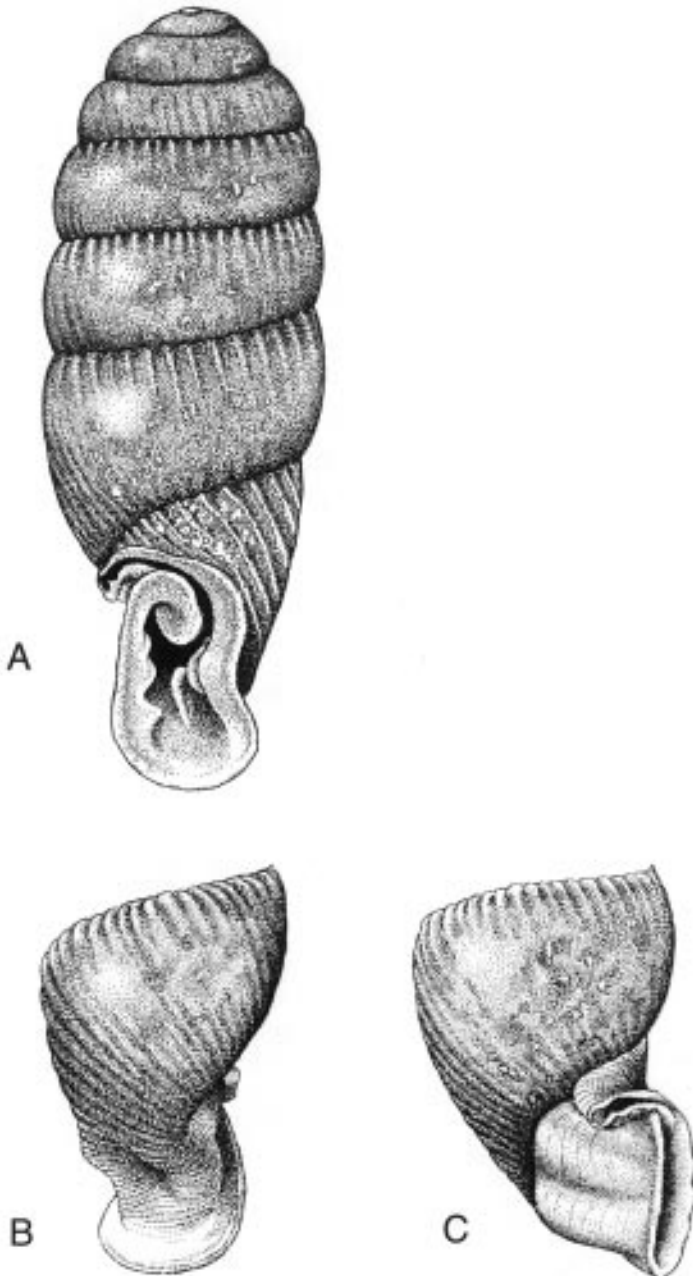
*Ecology.* The species was found among leaf litter along the road. Like *S. cameruniae*, it probably lives on the forest floor.

*Derivatio nominis.* The species is named after Manuel Iradier y Bulfi, born in Vitoria and the first explorer of the Muni River.

#### *Sinistrexcis fang* new species

*Material* (Fig. 1). Equatorial Guinea, Mitong River Falls, 1°8'35"N 9°52'20"E, MCNA 7007, holotype shell (broken to remove soft parts, but last 1 1/2 whorls and first 4 whorls preserved) and slide with genitalia), paratype (RMNH 57260/1 somewhat damaged shell).

*Shell* (Figs 5A–B). Shell elongate cylindrical, height 6 mm, H:D ratio 2.55 (holotype)-2.7 (paratype). Holotype shell transparent and

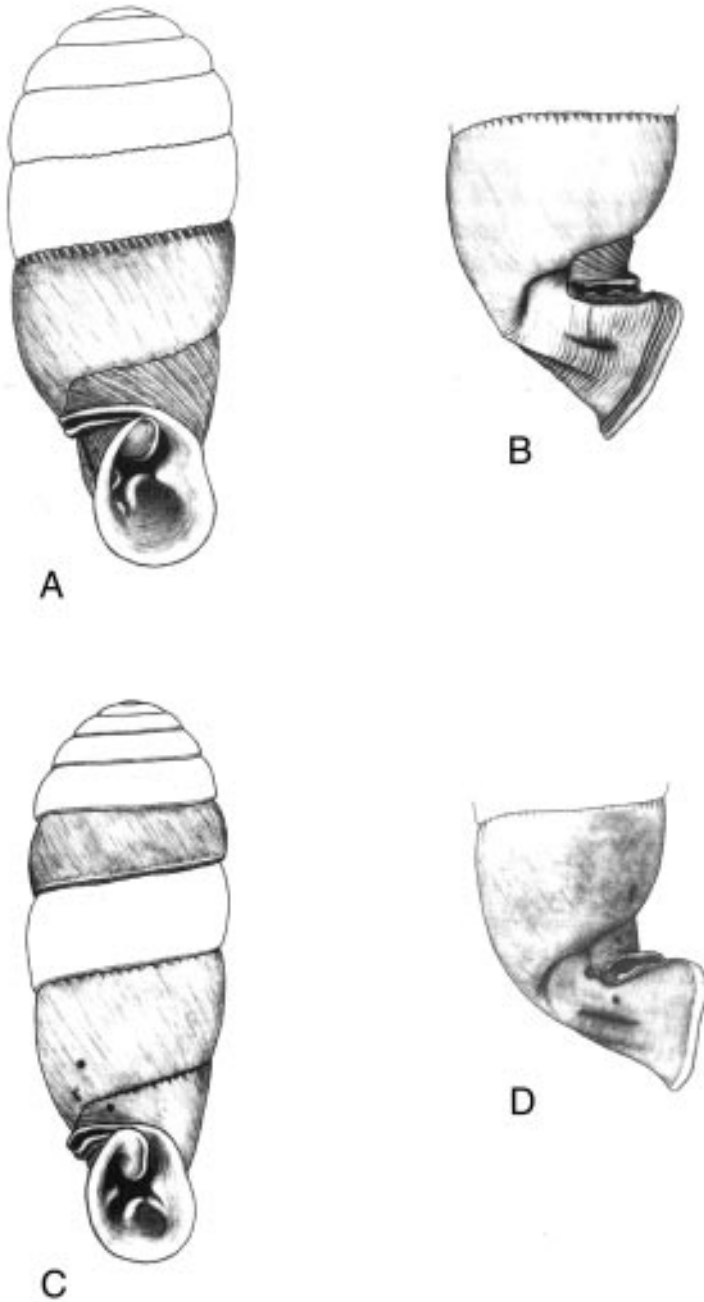


**Figure 4.** *Sinistrexcis iradiieri* new species. Holotype shell. **A.** Front view. **B-C.** Lateral views. Actual shell height 5.5 mm.

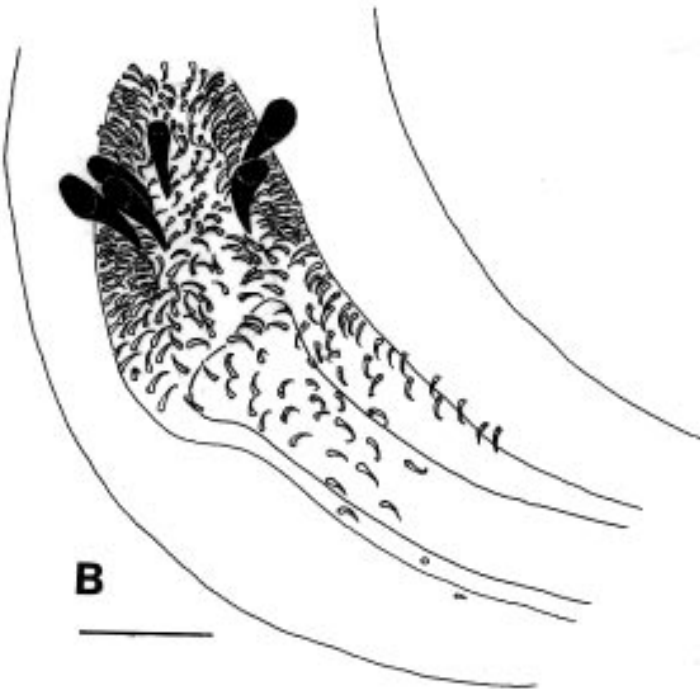
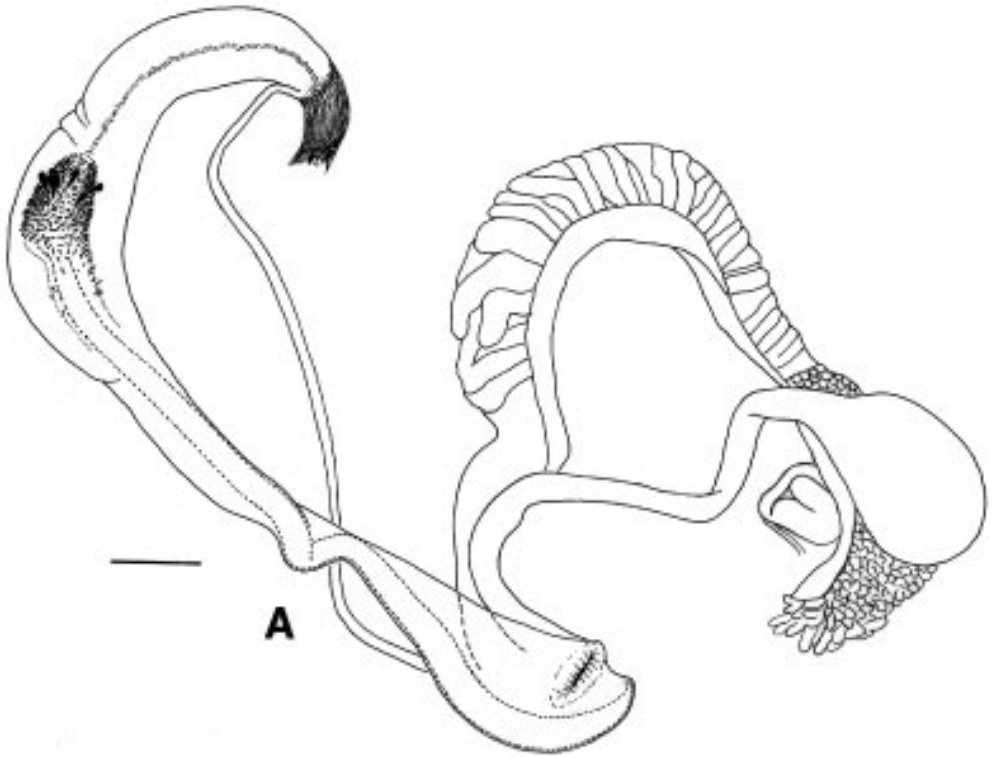
colourless, older paratype shell opaque white. Whorls 6 1/2–7, very little convex. Embryonic shell with about 1 1/2 whorls; first quarter whorl smooth, the later ones with very fine and slightly oblique axial grooves. Suture deep, dis-

tinctly crenulate. On the last half whorl the crenulations extend into regular ribs, superimposed on the grooves.

Peristome slightly reflected and thickened, margin rounded. Aperture pyriform, obstruc-



**Figure 5.** A–B. *Sinistrexisa fang* new species. Holotype shell. A. Front view. B. Lateral view. Actual shell height 6.0 mm. C–D. *S. cogoensis* new species. Holotype shell. A. Front view. B. Lateral view. Actual shell height 7.0 mm.





**Figure 6.** *Sinistrencisa fang* new species. Holotype. **A.** Genital system. Note presence of spermatophore in distal part of the penis; scale bar = 0.5 mm. **B.** Central portion of penis, showing arrangement of spines; scale bar = 0.2 mm.

ted by various plicae and lamellae. Sinus canal nearly horizontal and straight along its entire length, with a relatively wide and circular, terminal hole, and a poorly defined, subterminal, second one. Angular lamella high and prominent. Columellar border in lateral view obliquely positioned relative to coiling axis. Columellar wall with a medium-high, inrunning central lamella, and above and below two short folds, the lower one closest to the peristome, the upper one deeply set into the aperture. In the paratype the upper and lower columellar folds are virtually wanting. Palatal wall slightly concave, widening towards the peristome, and provided with two barriers: a blunt tooth close to the peristome, and a high lamella which ends at the inner base of the palatal tooth. Basal wall with a deeply set, inrunning, high lamella, which in the holotype starts close to the lower columellar fold. There are three external furrows, corresponding to the palatal, basal and columellar lamella inside the aperture, respectively, the basal one being the longest. Columellar furrow not extending beyond the end of the sinus canal.

*Genital system* (Figs 6A–B). Penis c. 6 mm long, somewhat distorted by an internally situated spermatophore. Penial morphology broadly similar to that described in *S. cameruniae*, but with a different inner spinulation. Proximal portion of penis cylindrical, about as long as the wider central portion. Walls of both upper portions thick and muscular. Distal portion thin-walled, obviously deformed by the presence of a spermatophore. The central portion contains more than 200 small (up to 40  $\mu\text{m}$  long), curved, spines, concentrated around six much bigger, brown spines (c. 100  $\mu\text{m}$  long). Atrium short. Vagina virtually absent. Pedunculus very long and slender, bursa copulatrix oval. Free oviduct short and wide, but not containing an egg.

The spermatophore inside the penis extends from the central portion into the atrium. Spermatophore tubular, c. 4 mm long and 130–160  $\mu\text{m}$  in diameter, longitudinally ribbed, with a falciform apex. Its rear end widens abruptly, and is positioned just below the dense cluster of small spines. In view of its position we think it is likely to be a self-produced spermatophore, just before of after being filled with sperm.

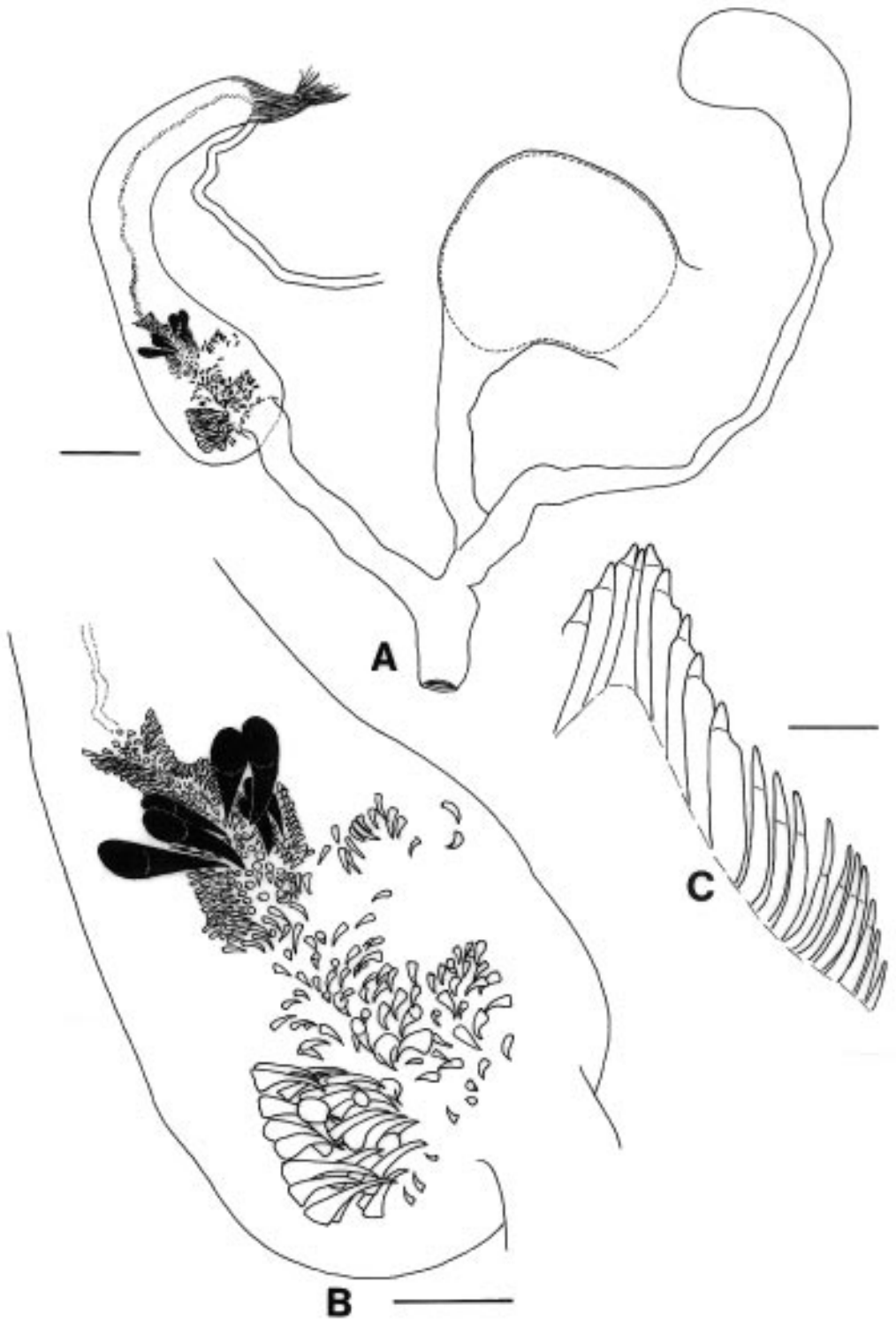
*Derivatio nominis.* The species is named after the Fang tribe, the group of people inhabiting large parts of continental Equatorial Guinea.

#### *Sinistrencisa cogoensis* new species

*Material* (Fig. 1). Holotype (MCNA 7006, shell (broken to remove soft parts, but last whorl and upper 4 1/2 whorls preserved) and slides with genitalia and radula: Equatorial Guinea, Vabe (20 km WNW of Cogo), 1°07'30"N 9°46'20"E, 27.VIII.1993, B. Gómez leg. Paratype (MNCN 15.05–27827/1 somewhat damaged shell): Equatorial Guinea, Rio Muni (3 km WNW of Cogo), 1°05'40"N 9°43'30"E, 21.VIII.1996, C. Prieto leg.

*Shell* (Figs 5C–D). Shell cylindrical fusiform, height 7.0 (holotype)-7.3 mm (paratype), H:D ratio 2.8. Whorls 8–8 1.4, rather flat, the first 5–7 whorls somewhat angular at their base, the remaining ones rounded, sculptured by slightly oblique axial grooves that extend over the entire whorl. Suture of upper whorls very deep, slightly crenulate, more distinctly crenulate on last two whorls. On the last, detached, quarter whorl the crenulations extend into regular ribs superimposed on the grooves (shell sculpture hardly visible in the holotype).

Peristome slightly reflected and thickened, with a rounded margin. Aperture ovate-pyriform, strongly protruding, obstructed by several plicae and lamellae. Parietal sinus virtually horizontal and straight in front view. Hind part of sinus with two comparatively wide (sub)circular dilatations. Angular lamella high and prominent. Columellar border of aperture curved in front view, nearly straight and parallel to the coiling axis in lateral view. Columellar wall with two folds, the upper one small and very deeply set, the lower one more robust and conspicuous, inrunning, nearly reaching the peristome. Palatal wall very slightly concave, expanding towards the base, provided with two barriers: a robust tooth, and a short and high lamella which ends at the inner base of the palatal tooth. Basal wall with a deeply situated, inrunning, high lamella. There are three external furrows, corresponding to the palatal, basal and columellar lamella inside the aperture, respectively, the basal one being the longest.



**Figure 7.** *Sinistrexica cogoensis* new species. Holotype. **A.** Genital system; scale bar = 0.5 mm. **B.** Central portion of penis, showing arrangement of spines; scale bar = 0.2 mm. **C.** Radula; scale bar = 20  $\mu$ m.

Columellar furrow extending beyond the end of the sinus canal.

**Genital system** (Figs 7A–B). Basic morphology of penis similar to that described in *S. cameruniae*, but relative dimensions to the three portions and the inner spinulation differ. Proximal portion (1.8  $\times$  0.4 mm) of penis longer and more slender than the central one (1.2  $\times$  0.75 mm). Distal portion relatively long and slender (1.5  $\times$  0.2 mm). Central portion with numerous, more or less curved spines of different sizes. Seven large (c. 200  $\mu$ m long), dark brown, relatively straight, spines are circularly arranged around the upper part of the penial lumen, amidst numerous tiny spines (c. 40  $\mu$ m). Another group of c. 25 spines of intermediate size (c. 150  $\mu$ m) is situated more laterally. The lower, wider part contains a large number of medium-sized and smaller spines, more or less arranged in size clusters. Atrium small. Vagina virtually absent. Pedunculus very long, widest distally. Bursa copulatrix elongate oval, attached to the albumen gland. The oviduct contains one spherical egg (1.4  $\times$  1.0 mm), which is covered by a mosaic of small quadrangular crystals (probably calcium carbonate). Several isolated pigment cells are embedded in the walls of the distal genitalia, especially in the widest part of the penis, which is coloured dark-brown.

**Radula** (Fig. 7C). There are c. 41 rows; formula 10 + 5 + C + 5 + 10. Central tooth well developed, c. 30  $\mu$ m long, narrow. Lateral teeth c. 40  $\mu$ m long, relatively wide, with weakly defined ectocones and prominent mesocones. Marginal teeth narrow, curved and unicuspid.

**Derivatio nominis.** The species is named after the main village of the region where the species was found.

#### PROVISIONAL KEY TO THE SHELLS

Three of the four species recognised in this study are rather similar in shell characters. Only after study of the genitalia did we become convinced that the conchological differences observed between *S. cameruniae*, *S. cogoensis* and *S. fang* could be used as diagnostic characters instead of representing intraspecific varia-

tion of a single species. In view of the scanty material available, the following key should be used with caution. More species can be expected.

- 1—Shell elongate ovoid, less than 6 mm high; whorls convex; palatal border of the aperture clearly concave in front view ..... *S. iradieri*  
 —Shell cylindrical, more than 6 mm high; whorls, especially the last three, rather flat; palatal border of aperture nearly straight in front view ..... 2
- 2—Shell with c. 8 whorls, at least 7 mm high; base of upper whorls angular, suture very deep; columellar margin of aperture more or less parallel to coiling axis (lateral view); columellar wall with two folds; aperture strongly protruding ..... *S. cogoensis*  
 —Shell with c. 7 whorls, up to 7 mm high; suture of upper whorls not particularly deep; columellar margin of aperture obliquely positioned relative to coiling axis (lateral view); columellar wall usually with three folds; aperture less strongly protruding ..... 3
- 3—Narrow part of sinus canal straight throughout its length; palatal tooth wide and blunt; space between angular lamella and suprapalatal wall comparatively wide ..... *S. fang*  
 —Hind part of sinus canal curved downwards; palatal tooth more acute; space between angular lamella and suprapalatal wall narrow ..... *S. cameruniae*

#### DISCUSSION

##### *Taxonomic affinities*

The systematic position of *Sinistrexica* within the Streptaxidae is unclear. Traditionally *Sinistrexica* would have been classified with the genus *Ptychotrema* Pfeiffer, 1853 *sensu lato*, because of the presence of at least one palatal fold in the aperture with externally on the body whorl a corresponding furrow (Pilsbry, 1919; Adam *et al.*, 1995). This character separates *Ptychotrema* s.l. from the even more heterogeneous genus *Gulella* which accommodates the vast majority of the Afrotropical enneid Streptaxidae species. The genus *Ptychotrema* s.l.

embraces about 10 named subgenera or sections (see Adam *et al.*, 1993, 1994, 1995 for an overview), and the affinities among these taxa remain unsettled in the absence of a detailed comparative anatomical study. Shell characters that separate *Sinistrex-cisa* from *Ptychotrema s.l.* are the long columellar lamella and corresponding external furrow, the extreme length and peculiar arrangement of the sinus, and the sinistral coiling of the detached part of the body whorl. In the Streptaxidae the latter character is otherwise known only in *Gulella jacquelineae* Adam, 1965. In many species of the Southeast Asian genus *Diaphera* Albers, 1850, the last part of the body whorl is detached from the spire, but continues to coil dextrally (cf. Zilch, 1961, Pls. 8–9).

By virtue of the slit-like sinus *Sinistrex-cisa* resembles *Excisa* d'Ailly, 1896, a taxon usually treated as a subgenus or section of *Ptychotrema*. However, in *Excisa* there are three palatal lamellae and two external furrows on the body whorl, and its sinus is much shorter and positioned differently. *Sinistrex-cisa* has only one palatal lamella and a corresponding external furrow, which character is shared with *Parennea* Pilsbry, 1919, and *Mirellia* Thiele, 1933. The numerous species of *Parennea* are regularly coiled and lack any sign of a prolonged sinus (Adam & Van Goethem, 1978; Van Bruggen, 1989). The detached part of the last whorl and the presence of a basal lamella and corresponding external depression could suggest affinity with the monotypic taxon *Mirellia*. The sinus in *Ptychotrema (Mirellia) prodigiosum* (E.A. Smith, 1903), however, is roundish instead of long and narrow (Adam *et al.*, 1995). The same holds for the only species of *Nsendwea* Dupuis & Putzeys, 1923, which, moreover, has two palatal lamellae (Dupuis & Putzeys, 1923; Adam *et al.*, 1995).

The penial morphology of *P. (Excisa) boangolensis* (d'Ailly, 1896) was described and figured by Ortiz de Zárate & Ortiz de Zárate (1955). In this species numerous smallish spines are present in most of the penis, but the 5–7 major spines as well as the tripartite division of the penis in *Sinistrex-cisa* seem to be absent. The species described as *Ptychotrema (Excisa) shagamuense* Oke & Odiete, 1996, does not belong to *Excisa*. The genital morphology, especially of the penis, of species attributed to *Ptychotrema s.l.*, as described by Degner (1934), Ortiz de Zárate & Ortiz de Zárate (1955), Van Bruggen (1989), Verdcourt (1990), Adam *et al.* (1993), and Oke & Odiete (1996), all deviate strongly from that of the *Sinistrex-cisa* species.

This does not imply, however, that we consider *Ptychotrema* or *Gulella* monophyletic or even paraphyletic taxa. Both within *Ptychotrema s.l.* and *Gulella s.l.* a few probably natural groups may be distinguished of which the taxonomic interrelationships are entirely unclear. A serious cladistic analysis is presently impossible since the anatomy of too many taxa remains unknown. The fact that the *Sinistrex-cisa* species represent both conchologically and anatomically a radiation that is distinct from any other *Ptychotrema* or *Gulella* taxon studied indicates that they are best considered as a separate genus.

#### Apertural morphology

We suggest that the peculiar morphology of the aperture in *Sinistrex-cisa* arose from a situation as found in *P. (Mirellia) prodigiosum*. One could envisage that an excessive retortion of the columellar wall to the right gave rise to the displacement of the basal and palatal walls in order to maintain a functional aperture. The sinus would become progressively longer in order to conserve its terminal hole relative to the aperture, via a position above the angular lamella, until it reached the extreme situation to the left of the aperture found in *Sinistrex-cisa*. The anal-pneumostomal complex (APC) is normally situated near the parieto-palatal corner, where various streptaxids have developed a more or less elaborate sinus, which might facilitate the performance of the APC when the animal is retracted into its shell. In *Sinistrex-cisa*, however, the 'breathing hole' has become far removed from the APC, but gas exchange could remain possible by muscular movements of the foot and mantle when a resting snail is firmly adhered to, for example, a leaf, which Rees (1964) suggested to be the case in various land prosobranchs with breathing canals. In the crawling snail the APC is situated between the angular lamella and the palatal barriers.

The development of a slit-like sinus not only occurs in some taxa of *Streptaxidae* (*Excisa*, *Discartemon*), but also in the European land prosobranch *Renea* (Boeters *et al.*, 1989). Various taxonomically diverse taxa of tropical land prosobranchs exhibit a great variety of peculiar breathing holes and canals (Rees, 1964). It would be interesting to carry out a comparative ecological study of these taxa. Most species possessing such structures appear to be ground dwellers.

*Spermatophore*

As far as we know, *Sinistrexica* is the first streptaxid in which a spermatophore has been reported. The only feasible place where the spermatophore could be moulded is in the upper portion of the penis. Since this part is rather short relative to the length of the spermatophore, the formation of the spermatophore is likely to be a gradual process, during which the portion formed is pushed into the thin-walled lower penis, where it is temporarily stored. Once the formation is completed, the spermatophore can be filled with sperm. Possibly the numerous spines in the central penis take part in this process, rather than in the mating behaviour.

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