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A new Phasmatodea for French Guiana, *Creoxylus paradoxus* (Kirby, 1904), and notes on the stick-insects of Réserve Naturelle Nationale de la Trinité

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Abstract. – ASPER (Association pour la Systématique des Phasmes et l'Étude de leur Répartition) was appointed by Office National des Forêts of French Guiana to produce an inventory of the Phasmatodea of Réserve Naturelle Nationale de la Trinité. This allowed the discovery of *Creoxylus paradoxus* (Kirby, 1904), which constitutes a new record for French Guiana. The male and the egg are described for the first time, and a redescription of the female is proposed. It is compared to its sister taxon *Creoxylus spinosus* (Fabricius, 1775). Information on its biology is also documented. A new combination is proposed for *Acanthoclonia histrinus* (Westwood, 1859) which becomes *Creoxylus histrinus* (Westwood, 1859), n. comb. Finally, a list of the 15 species collected is provided.

Résumé. – **Un nouveau Phasmatodea pour la Guyane : *Creoxylus paradoxus* (Kirby, 1904) et notes sur les Phasmes de la Réserve Naturelle Nationale de la Trinité**. L'ASPER (Association pour la Systématique des Phasmes et l'Étude de leur Répartition) a été missionnée par l'Office National des Forêts de Guyane pour réaliser l'inventaire des Phasmatodea de la Réserve Naturelle Nationale de la Trinité. Celui-ci a permis la découverte de *Creoxylus paradoxus* (Kirby, 1904), constituant une donnée nouvelle pour la Guyane. Le mâle et l'œuf sont décrits pour la première fois, et une redescription de la femelle est proposée. Cette espèce est comparée avec son espèce-sœur *Creoxylus spinosus* (Fabricius, 1775). Des informations sur sa biologie sont fournies. Une nouvelle combinaison est proposée pour *Acanthoclonia histrinus* (Westwood, 1859) qui devient *Creoxylus histrinus* (Westwood, 1859), n. comb. Enfin une liste des 15 espèces inventoriées est donnée.

Keywords. – Inventory, taxonomy, description, biology, host plants, egg, new combination.

In 2016, the Office National des Forêts requested ASPER to produce an inventory of the Phasmatodea of the Réserve Naturelle Nationale de la Trinité in French Guiana. Two members (Yannick Bellanger and Philippe Lelong) took part in a field expedition from November, 2nd to 9th, in the camp Aya. In February 2017, ASPER team left the collected specimens in the collections of MNHN. Among the species found, one was a new record for French Guiana and another may be new to science. The latter should be described in a forthcoming paper with our German colleagues Oskar Conle and Frank Hennemann.

Material and methods

Measurements are given in millimeters with a precision of ± 0.1 mm for the adults and ± 0.01 for the eggs. The classification in use follows taxonomic arrangements proposed by Zompro (2001, 2004). Information on the type of *Creoxylus paradoxus* (Kirby, 1904) comes from online database Phasmida Species File (Brock *et al.*, 2017) and this specimen was examined with high definition pictures provided by the Natural History Museum of London. The remaining examined material comes from the expedition in the natural reserve and the ASPER collection. Collecting and preserving methods are described in Jourdan *et al.* (2014).

Abbreviations used. – **MNHN** : Muséum national d'Histoire naturelle, Paris, France; **BMNH** : The Natural History Museum, London, United Kingdom; **ASPER :** Association pour la Systématique

des Phasmes et l'Etude de leur Répartition (Le Ferradou n°3, 31570 Sainte-Foy-d'Aigrefeuille, France) - http://www.asper.org; **RNN** : Réserve Naturelle Nationale.

List of reported species

All the species observed and collected during the expedition are listed in the table I. Among the listed species, two were not observed directly during this study: *Prisopus horstokkii* (De Haan, 1842), which was found previously on site by *Société entomologique Antilles-Guyane* (BRULÉ *et al.*, 2011: 66); and *Cladomorphus gibbosus* (Chopard, 1911) for which a specimen was already collected in 1998 by Alexandre François and given to ASPER.

Table I. – List of the reported species at Réserve Naturelle Nationale de la Trinité.

Family	Genus	Species
Diapheromeridae	***Phanocloidea*** Zompro, 2001	***muricata*** (Burmeister, 1838)
	Phanocles Stål, 1875	*sp*.
Phasmatidae	***Pterinoxylus*** Audinet-Serville, 1838	***eucnemis*** (Burmeister, 1838)
	Cladomorphus Gray, 1835	***gibbosus*** (Chopard, 1911)
Pseudophasmatidae	***Pseudophasma*** Kirby, 1896	***flavipes*** (Chopard, 1912)
		phthisicum (Linné, 1758)
	Cesaphasma Koçak & Kemal, 2010	***servillei*** (Zompro, 2000)
	Creoxylus Audinet-Serville, 1838	***spinosus*** (Fabricius, 1775)
		paradoxus (Kirby, 1904)
	Isagoras Stål, 1875	***affinis*** Chopard, 1912
	Metriophasma Uvarov, 1940	***baculus*** (Degeer, 1773)
		pallidum (Chopard, 1912)
	Prexaspes Stål, 1875	***cneius*** (Westwood, 1859)
Prisopodidae	***Dinelytron*** Gray, 1835	***agrion*** Westwood, 1859
	Prisopus Le Peletier de Saint-Fargeau & Audinet-Serville, 1828	***horstokkii*** (De Haan, 1842)

Areolatae, Pseudophasmatidae, Xerosomatinae, Xerosomatini

Genus ***Creoxylus*** Audinet-Serville, 1838

Creoxylus paradoxus (Kirby, 1904)

Acanthoclonia paradoxa Kirby, 1904: 444. Holotype: ♀, Forest Santarem, Lower Amazon (Brazil), BMNH(E) #845341 [BMNH].

Material examined. – *In* MNHN: 1 ♂, GUYTRI16-020 and 1 ♀, GUYTRI16-027, Guyane, RNN de la Trinité, Layon A, 4°36'03,5''N - 53°25'03''O, alt. 121 m, 4.XI.2016, rec. & det. *P. Lelong & Y. Bellanger*. *In* coll. ASPER: 10 eggs laid by the collected female.

Notes. – This constitutes the first data for this species in French Guiana. Until now it was only known from the holotype female housed in BMNH, from a specimen collected near Santarem in Brazil. The female collected in RNN is slightly larger than the holotype but overall the proportions match. Assessing the original description by Kirby and examination of the holotype leave no doubt that both specimens belong to the same species, namely *Creoxylus paradoxus*. Collected specimens were found together and mating was observed directly. The pair was feeding on 10-20 cm high stems of the plant *Protium sagotianum* Marchand (Burseraceae). Breeding was possible in Europe on *Eucalyptus sp.* (Myrtaceae) and *Tradescantia sp.* (*zebrina*?) (Commelinaceae). The species seems to live on litter: both specimens were collected on the ground on dead leaves of the litter; in artificial breeding settings, the female brought back alive was always evolving on the ground and climbed quite exceptionally on the leaves or stems. The female glues the eggs

on the ground most of the time and quite rarely on leaves. In artificial rearing conditions, eggs were stuck in its own faeces, which seems to be an unprecedented behaviour for a Phasmatodea species. Egg laying frequency was very low, about one egg per week on average. At first sight the male is hard to differentiate from the male of *Creoxylus spinosus* (Fabricius, 1775); it mainly differs in the characters provided in table II.

Until now, the eggs of the genus *Creoxylus* were only known for *C. spinosus*. The way the eggs of *C. paradoxus* are laid is directly impacting their appearance as they are almost always covered with decaying organic matter. The egg of *C. paradoxus* is covered by fine hairs on its posterior pole, which could increase the adherence of faeces. The comparison of eggs from the two species allowed us to describe useful delineating criteria for ootaxonomy, as listed in table II; the egg of *C. paradoxus* shows an opercular angle and the capsule is much longer than high.

Table II. – Characters of distinction for males, females and eggs of *Creoxylus paradoxus* and *Creoxylus spinosus*.

		***C. paradoxus* (Kirby, 1904)**	***C. spinosus* (Fabricius, 1775)**
♂	Diverging excrescences on the head, view from above (fig. 16-17)	Not exceeding lateral edges of the head; apex slightly rounded (fig. 16)	Exceeding lateral edges of the head; apex pointed (fig. 17)
	Basal quarter of tegmina (fig. 18-19)	Slightly bumped (fig. 18)	With a strikingly visible bump (fig. 19)
	Mesonotum	With 1 short thorn on each side of the median-furrow	With 2 long thorns on each side of the median-furrow
♀	Wings	With micro-wings and full developed tegminae	Wingless but with tiny tegminae
	Subgenital plate (fig. 20-21)	Reaching the anterior part of the anal segment (fig. 20)	Exceeding the anal segment (fig. 21)
	Gonapophyses (fig. 20-21)	Strikingly exceeding the subgenital plate but not the anal segment (fig. 20)	Reaching the extremity of the subgenital plate (fig. 21)
egg	Glued with excrements	Yes	No
	Opercular angle (fig. 22-23)	10° (fig. 23)	0° (fig. 22)
	Capsule	1.7× as long as high	1.3× as long as high

Redescription of the female. – Fig. 1-6. Original description in Kirby (1904: 444). Size medium for the genus. General coloration of body and legs dark brown. Entire body surface and legs irregularly rugulose, granulose and tuberculose. With micro-wings and fully developed tegminae.

Head slightly longer than wide, almost quadrate in dorsal view, surface covered with large tubercles; upper part elevated with a pair of hemi-discoidal crenulated excrescences, which extend slantwise by roughly two thirds of the head height, and joining together anteriorly between the eyes. Eyes oriented at almost 45° from the lateral borders of the head. Antennae slender and reaching the middle of posterior half of the tegmina. Scapus arcuate inward, granulose, flattened dorsally, distinctly carinate; pedicellus cylindrical and representing a little more than one third of the length of scapus.

Thorax. Surface of pro- and mesonotum very wrinkled and irregularly covered with large and abundant tubercles. Pronotum about as long as wide, slightly wider and distinctly shorter than head; transverse median sulcus distinct, gently curved and expanding over entire width of segment, forming a small cross with the longitudinal sulcus. Mesonotum about 1.7× as long as pronotum, roughly parallel-sided dorsally and with only the very posterior portion slightly widened; with a distinct longitudinal sulcus; lateral margins slantwise in lateral view, forming a rising diagonal until the tegmina (fig. 6). Metanotum almost quadrate. Meso- and metasternum rugose and wrinkled, with a medio-longitudinal carina and several small dark tubercles. Tegmina covering the metanotum and reaching the anterior part of median segment; external margin of tegmina almost straight with a small bump, internal margin rounded, and apically rounded.

Abdomen. Median segment about as long as metanotum. Abdominal segments III and IV dorsally of same length, very slightly longer than II; VII very slightly longer than III and IV; V and VI the longest and of

same length; VIII and X shorter and of same length; IX distinctly the shortest. Anal segment anteriorly wider than long, narrowed in its posterior third and with rounded extremity. Sternites II to VII rugose with two irregular carinae. Cerci very small, subconical with rounded apex, not visible dorsally. Gonapophyses well developed and visible, strikingly exceeding subgenital plate but not the anal segment. Subgenital plate triangular with an acutely pointed apex, reaching the anterior part of anal segment.

Legs. All femora longer than their associated tibia. Profemora very gently compressed basally, dorsal carinae with small tubercles and a small lobe anteriorly. Protibiae with two lobes on both dorsal carinae, more or less pronounced. Mesofemora with two small lobes on the dorso-posterior carina and two larger lobes wave-shaped on the ventro-anterior carina. Meso- and metatibiae dorsally with a large

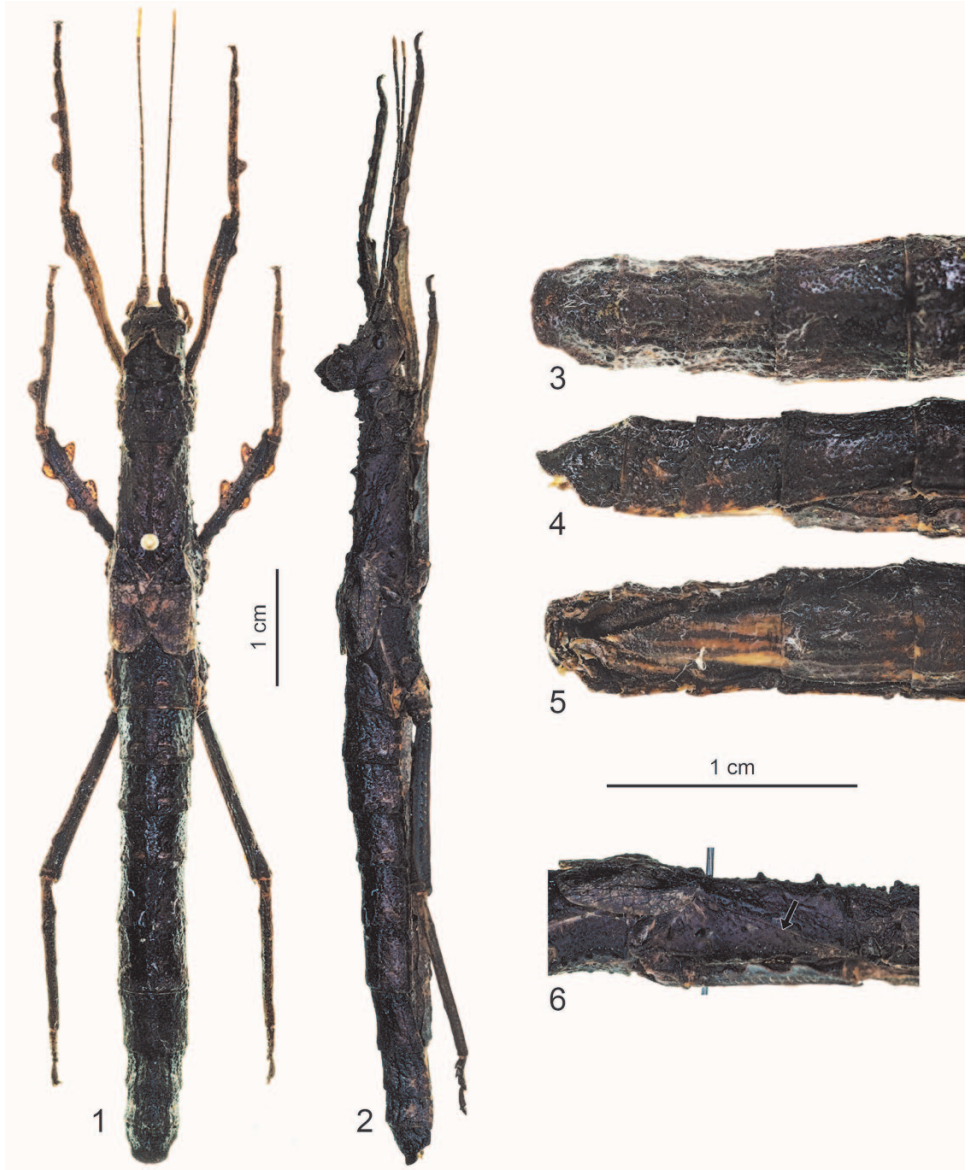

Fig. 1-6. – *Creoxylus paradoxus* (Kirby), ♀. – **1-2**, Habitus: 1, dorsal view; right lateral view. – **3-5**, Abdominal extremity: **3**, dorsal view; **4**, lateral view; **5**, ventral view. – **6**, Close-up on the lateral margin of mesonotum (the arrow shows the slantwise lateral margin).

lobe on the posterior part, and another smaller anteriorly at the two thirds of their length. Metafemora with two lobes on the dorso-posterior carina. All basitarsi slightly shorter than three next ones combined.

Description of the male. – Fig. 7-11. General coloration of body and legs dark brown. Body surface strongly wrinkled and bearing granules and tubercles.

Head. Longer than wide, roughly rectangular in dorsal view, very rough, bearing granules and tubercles; upper part more elevated with two diverging excrescences, triangular-shape and with rounded apex; coloration dark brown, marbled with light brown areas. Eyes hemispherical and hardly projecting, orange marbled in dark brown. Antennae slender, strongly projecting over the anterior legs; coloration ranging from light brown to yellowish for the three last antennary articles; scapus flattened dorsally and covered by longer hairs on its internal side, 1.6× as long as the pedicellus.

Thorax. Pronotum almost quadrate and covered with small tubercles. Mesonotum granulose, covered with small tubercles and with a short spine with rounded apex on each side of the mediolongitudinal furrow in its anterior part. Tegmina slightly suboval, 3.75× shorter than alae, slightly bumped in the basal quarter; venation thick and forming cells of irregular shape. Alae reaching the anterior edge of tergite IX; basal quarter of costal area yellowish to light orange and distal three-quarter light brown with darker spots; anal area greyish and translucent.

Abdomen. Cerci slightly flattened, hairy and with rounded apex, not visible in dorsal view. Sternites granulose and with sparse small tubercles; II to VIII with irregular ridges; II with two whitish bean-shaped marks in its anterior border; VIII the shortest; anterior third of IX with a medio-longitudinal furrow, central part with a darker depression, posterior third clearer and with a medio-longitudinal ridge. Vomer well visible, triangular in shape but with undulate external borders, with a mediolongitudinal cleft and almost reaching the apex of tergite X.

Legs. Trapezoidal in cross section. All femora longer than their related tibia. Profemora smooth, slightly curved and compressed basally. Mesofemora with four striking lobes in thorn shape on its dorso-anterior carina, and three rounded lobes on the dorso-posterior and dorso-anterior carinae face to face. Metafemora and metatibiae straight and smooth. Posterior carinae of all tibiae very close from each other, forming a median furrow between them; ventro-posterior carina of pro- and mesotibiae with a lobe at about one third and another at two thirds of its length. All basitarsi shorter than the three following combined and about one third of tarsus length.

Description of the egg. – Fig. 12-15.

Capsule stuck with plants debris from admixed faeces; dark brown to beige but often stained by faeces especially in on posterior pole; minutely granulose; cylindrical, rounded in the posterior part and slightly narrowed on the collar; 1.9× as long as wide, 1.7× as long as high, slightly higher than wide; ventral face almost straight and dorsal face very slightly convex.

Micropylar plate ovoid and almost oval, representing about one fourth of the capsule length, more than 1.3× as long as large and getting slightly narrower in its anterior part; capsule forming a thin border all around the micropylar plate. Micropylar cup conspicuous. Median line distinct but partly covered by the agglomerated filaments.

Operculum ovoid and almost circular, large diameter about 1,1× as long as the smallest; periphery slightly granulose, central part more granulose and slightly elevated. Collar forming a ridge slightly granulose. Operculum covered with a very thin net crisscrossed by lighter filaments. Opercular angle about 10°.

Measurements *(millimeters). – Female*. – Body: 75.7; antennae: 23.4; head: 6.9; pronotum: 6.4; mesonotum: 11.3; metanotum: 5.3; median segment: 5.2; profemora: 14.8; mesofemora: 12.6; metafemora: 15.5; protibiae: 11.9; mesotibiae: 10.3; metatibiae: 13.4; tegmina: 9.0; alae: 4.0.

Male. – Body: 53.2; antennae: 35.8; head: 3.5; pronotum: 2.9; mesonotum: 7.8; metanotum + median segment: 7.5; profemora: 12.8; mesofemora: 9.9; metafemora: 13.3; protibiae: 12.2; mesotibiae: 8.8; metatibiae: 12.2; tegmina: 9.1; alae: 34.2.

Egg. – Capsule length: 4.10; capsule height: 2.37; capsule width: 2.13; small diameter: 1.45; large diameter: 1.61.

Differentiation. – The only other known species of the genus in French Guiana is *Creoxylus spinosus* (Fabricius, 1775). Males of *C. paradoxus* differ by the excrescences on the head not

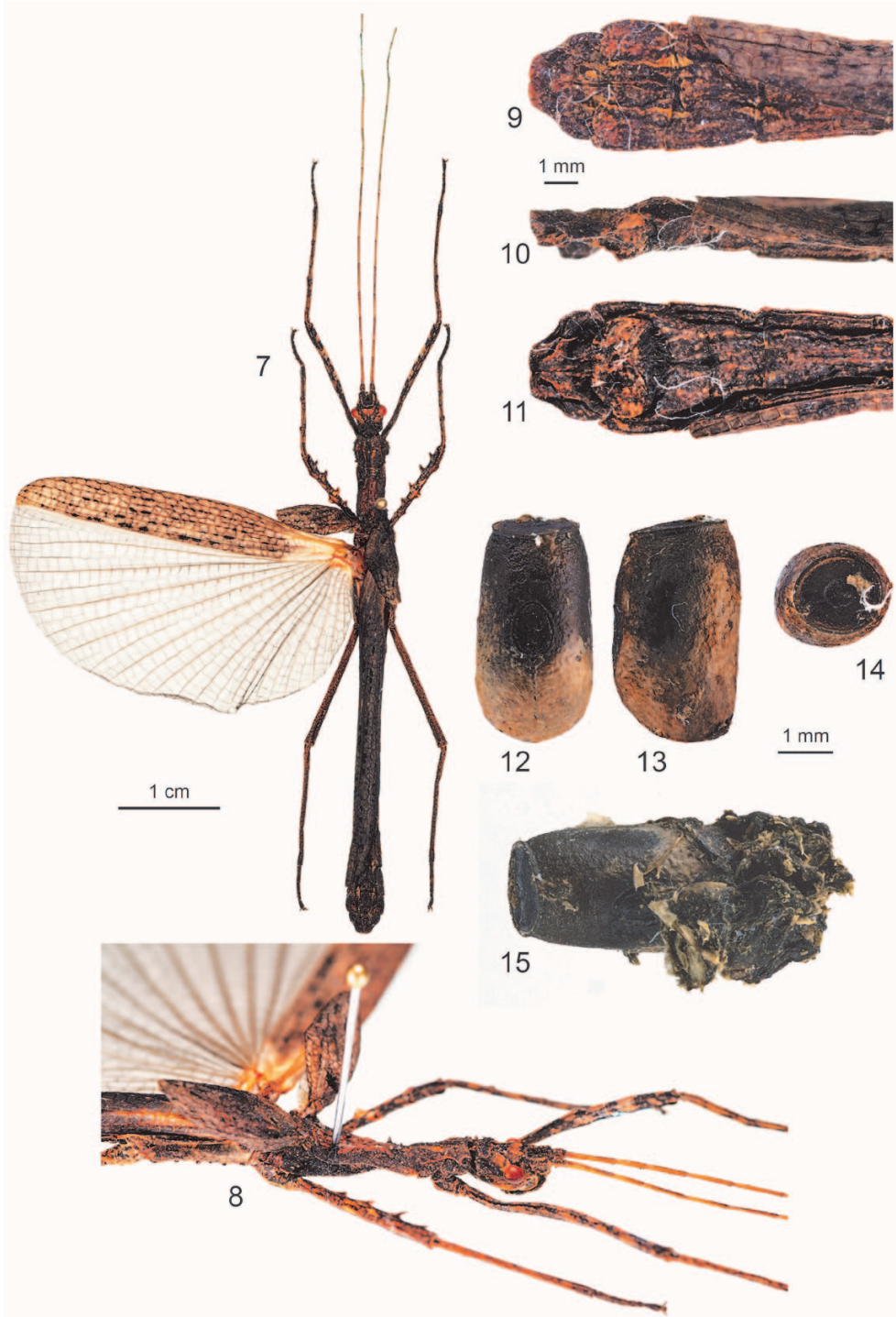

Fig. 7-15. – *Creoxylus paradoxus* (Kirby). – **7-11**, ♂: **7**, habitus, dorsal view; **8**, head and thorax, lateral view; **9-11**, abdominal extremity (**9**, dorsal view; **10**, lateral view; **11**, ventral view). – **12-15**, Egg: **12-14**, details (**12**, dorsal view; **13**, lateral view; **14**, dorsal view of the operculum); **15**, with excrements.

exceeding the lateral edges of the head and with slightly rounded apex (fig. 16-17), basal quarter of tegmina slightly bumped and mesonotum with one short thorn on each side of the median-furrow (fig. 18-19); the female of *C. paradoxus* has micro-wings and full developed tegminae, a shorter subgenital plate which just reaches the anterior part of anal segment, and shorter gonapophyses which exceed the subgenital plate but not anal segment (fig. 20-21); the egg (fig. 22-23) is much longer, has an opercular angle of 10° and is glued with excrements while the one of *C. spinosus* is not glued and has no opercular angle (table II).

Other species of the genus differ as follow: *Creoxylus auritus* Conle, Henneman & Gutiérez, 2011 (♂) and *C. impennis* Redtenbacher, 1906 (♂♀) are wingless; *C. biaculeatus* Conle, Henneman & Gutiérez, 2011 (♀) and *C. cristatus* Conle, Henneman & Gutiérez, 2011 (♀) are

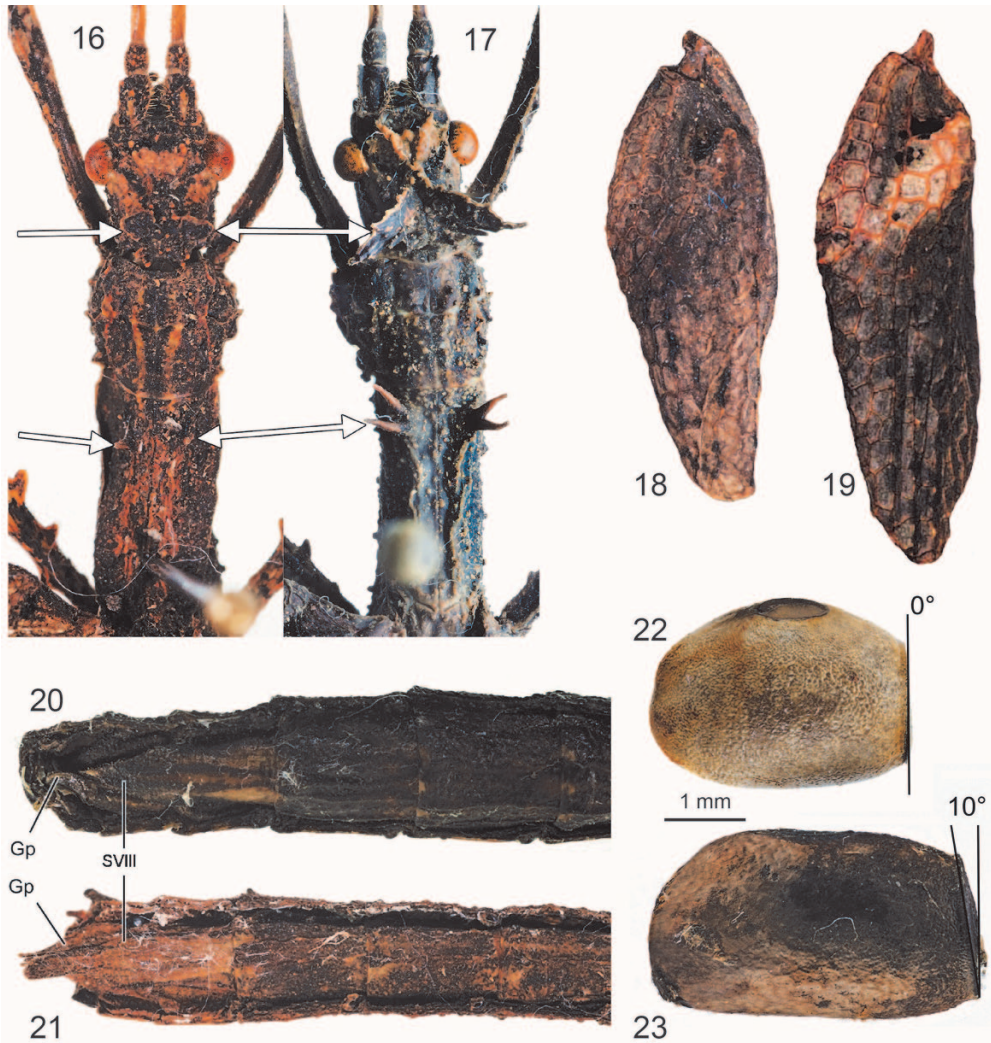

Fig. 16-23. – *Creoxylus*, comparison between species of French Guiana. – **16-17**, Head and thorax of male, dorsal view: **16**, *C. paradoxus* (Kirby); **17**, *C. spinosus* (Fabricius). – **18-19**, Tegmina of male, dorsal view: **18**, *C. paradoxus*; **19**, *C. spinosus*. – **20-21**, Abdominal extremity of females, ventral view: **20**, *C. paradoxus*; **21**, *C. spinosus*. – **22-23**, Opercular angle of egg: **22**, *C. paradoxus*; **23**, *C. spinosus*. Abbreviations: Gp, gonapophyses; SVIII, sternite VIII / subgenital plate.

wingless too and have remarkable swellings or lobes on tergites VI and VII; *C. corniger* Audinet-Serville, 1838 (♂) is larger, has no spines on mesonotum and has only 4 lobes on mesofemora; *C. hagani* Redtenbacher, 1906 (♀) is the species most closely similar to *C. paradoxus* but has a longer subgenital plate, which strikingly exceeds anal segment, and much longer gonapophyses; *C. poeyi* Saussure, 1868, was described from a nymph and clearly does not belong to genus *Creoxylus* but more material is needed for further taxonomical study.

Creoxylus histrinus (Westwood, 1859), **n. comb.**

Ceroys histrinus Westwood, 1859: 60.
Acanthoclonia histrinus (Westwood); Kirby, 1904: 407.

After close examination of photos of the holotype (Brock *et al*., 2017) and the original description (Westwood, 1859), *Acanthoclonia histrinus* (Westwood, 1859) is here transferred to *Creoxylus* Audinet-Serville, 1838, a genus it more closely matches compared to its current status. This species indeed differs from *Acanthoclonia* Stål, 1875, in the lack of the typical armature on mesonotum and the anal segment not being much narrower than tergum IV; furthermore, the subgenital plate reaches about half of anal segment length while it is actually much shorter in *Acanthoclonia*. Moreover, it also shares with *Creoxylus* a cylindrical and elongated abdomen, as well as a tergum X narrower than IX only in its posterior half. This species (♀) differs from *C. paradoxus* in its spiny thorax, lack of wings, a very different ornamentation of head and the posterior dorsal swellings on tergites.

Complementary information

The feeding biology of several species is completed here by direct field observations and further rearing in French Guiana. *Phanocloidea muricata* was observed feeding on *Cordia nodosa* Lam. (Boraginaceae). *Pterinoxylus eucnemis* was eating leaves of a yet not identified bush of the family Myrtaceae. Nymphs and adults of *Cesaphasma servillei* were always observed on *Miconia sp*. and *Miconia acuminata* (Steud.) Naudin (Melastomataceae), which they eat. *Creoxylus spinosus*, which seems very polyphagous, was further observed feeding on *Spermacoce ocymifolia* Willd. ex Roem. & Schult. and *Spermacoce verticillata* L. (Rubiaceae).

The density of Phasmatodea in the reserve seems to be rather low, except in fully open areas like camp and drop-zone. The most common species was *Cesaphasma servillei*, followed by *Phanocloidea muricata* and *Creoxylus spinosus*. These three species constitute 63% of the total number of observed sample. During this expedition, 27 specimens were collected, which represents about half of the observed individuals.

Conclusion

This inventory expedition allowed recording in French Guiana a species until now only known from Brazil by the female type-specimen: *Creoxylus paradoxus* (Kirby, 1904). This is a new record for Phasmatodea diversity of French Guiana. Until this inventory in November 2016, only one species of Phasmatodea was known from Réserve Naturelle Nationale de la Trinité. The present work allowed to increase up to 15 the number of locally census species, but this list is obviously not exhaustive yet. We know that many Phasmatodea species demonstrate a low density in French Guiana, making their observation rare. In the inventory list indeed, several species were observed only once during the expedition; it is reasonable to think that there are still other species to discover in the reserve. Furthermore, it is known that canopy is a species rich environment for Phasmatodea but it remains hard to access and is thus still poorly evaluated. Other species living in this niche are probably awaiting discovery.

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