An investigation of morpho-anatomical characters within the genus *Genetta* (Carnivora, Viverridae) with a remark on *Osbornictis*, the aquatic genet

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Introduction

The Viverrinae subfamily remains a controversial taxonomic group. Therefore, it has been subjected to many systematic reappraisals, mostly based on morpho-anatomical considerations (GRAY, 1864; MIVART, 1882; POCOCK, 1915; GREGORY and HELLMAN, 1939; WOZENCRAFT, 1989). Moreover, phylogenetic relationships within this group, although poorly considered, are liable to discussions and opposite scenarii have been proposed (POCOCK, 1915; GREGORY and HELLMAN, 1939; PETTER, 1969; KINGDON, 1977; CRAWFORD-CABRAL, 1993; VERON, 1995).

Some taxa (notably members of the genera *Genetta* and *Poiana*) are also subject to doubtful specific delimitations (ROSEVEAR, 1974;

SCHLAWE, 1981; CRAWFORD-CABRAL, 1981a and b; CRAWFORD-CABRAL and PACHECO, 1992; CRAWFORD-CABRAL, 1993; WOZENCRAFT, 1993; KINGDON, 1997), often due to a lack of diagnostic characters in their initial descriptions. As a consequence, the current Viverrinae classifications fail to propose similar taxa sets, both from quantitative or qualitative viewpoints (GRZIMEK, 1990; NOWAK, 1991; WOZENCRAFT, 1993; KINGDON, 1997).

We can easily imagine the headache that the Viverrinae –and especially the genets– may represent for people concerned by their identification and classification, that is to say naturalists and/or collection curators. With the aim to clarify interspecific limits within the genus *Genetta*, we undertook an exhaustive examination of morpho-anatomical characters. Although previous identification keys related to the genets do already exist (COETZEE, 1971; ROSEVEAR, 1974; CRAWFORD-CABRAL, 1981b), diagnostic characters which are proposed (craniometrical measures, coat colours, spots pattern, etc.) generally seem not easily applicable to species differentiation. Thus, two identification keys (one based on cranial characters and the other one based on coat characters) are here presented for the genus *Genetta*.

Material and methods

Most of the specimens used in the present study belong to the Paris Natural History Museum (MNHN) collections (Laboratoire de Zoologie: Mammifères et Oiseaux, and Laboratoire d'Anatomie comparée), but the Musée Royal de l'Afrique centrale of Tervuren (MRAC) and the London Natural History Museum (NHML) also allowed us to complete our taxonomic set.

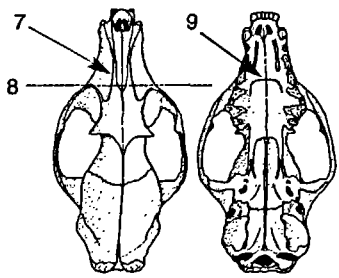
Characters taken into account to discriminate each taxon (skull and coat) were at first determined on non-ambiguously delimited species (the so-called « genet-like » species as *Osbornictis piscivora*, *Prionodon linsang* and *Prionodon pardicolor*, and also some genet species as *Genetta johnstoni*, *Genetta victoriae* and *Genetta thierryi*), and then applied to the other taxa.

Results

Identification keys

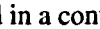
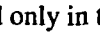
Cranial characters

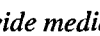
1. *Foramen magnum:* – compressed ..... *G. johnstoni*
   – not compressed 2
2. *Fronto-nasal suture:* – bilobate ..... *G. thierryi*
   – unilobate 3
3. *Sagittal crest:* – absent 4
   – present 6
4. *Postorbital process:* – strong 5
   – weak 8
5. *Postero-accessory cusp (P_2):* – present ..... *G. abyssinica*
   – absent ..... *G. tigrina*
6. *Entotympanic bone:* – not inflated ..... *G. "rubiginosa"*
   – inflated 7
7. *Premaxillo-frontal contact:* – present ..... *G. pardina*
   – absent ..... *G. angolensis*
8. *Fronto-nasal suture:* – subsequent to the upper border of the lachrymal bone ..... *G. genetta*
   – at the level of the upper border of the lachrymal bone 9
9. *Maxillo-palatine suture:* – subsequent to the P^3 main cusp ..... *G. victoriae*
   – aligned with the P^3 main cusp ..... *G. servalina*



Coat characters

1. *Mid-dorsal line:* – clear in the middle and dark-bordered 2
   – discontinuous 3
   – continuous and down stroke 4

2. *Spots of the first latero-dorsal row:*
   – merged in a continuous line  .....*G. abyssinica*
   – merged only in the back part  .....*G. thierryi*

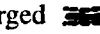
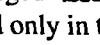
3. *Pair of wide median nuchal stripes:* – absent.....*G. servalina*
   – present  .....*G. victoriae*

4. *Tip of the tail:* – clear.....*G. genetta*
   – dark 5

5. *Upper labial spots*: – small and not very contrasting ...*G. johnstoni*
   – wide and very contrasting.....6

6. *Upper part of the hind leg*: – poorly spotted .....*G. tigrina*
   – extensively spotted 7

7. *Width of the spots of the first latero-dorsal row*:
   – wider than the mid-dorsal line .....*G. "rubiginosa"*
   – equal to the mid-dorsal line 8

8. *Spots of the first latero-dorsal row:*
   – not merged  .....*G. pardina*
   – merged only in the back part  .....*G. angolensis*

Reconsideration of Osbornictis piscivora *(Allen, 1919) plantar pads description*

Our exhaustive examination of morpho-anatomical characters (applied to a large set of Viverrinae) allowed us to reconsider the plantar pads description of *Osbornictis piscivora*, as ALLEN (1924) did not mention the presence of the metatarsal pads (nomenclature from POCOCK, 1915) in his type-specimen illustration. The examination of the specimen 87-68-M1 (MRAC) permits to determine distinct metatarsal pads, even if they seem merged with the hairless plantar structure (fig.1).

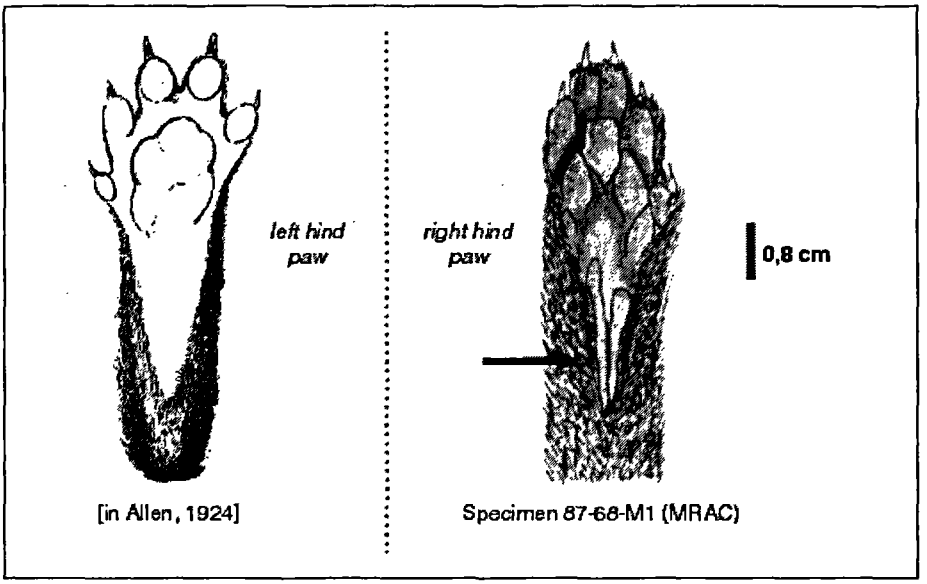


Figure 1
Allen illustration (left) (Allen, 1924 : by courtesy of the American Museum of Natural History) and new illustration (right) of the *Osbornictis piscivora* plantar pads.

Discussion

Regarding the genet "species" that occur in the identification keys, we must clarify some taxonomic points. Indeed, the observation of diverse characters led us to make associations and discriminations within some still status-debated taxa:

– no distinction between *Genetta genetta* (Linné, 1758), *Genetta felina* (Thunberg, 1811) and *Genetta senegalensis* (Fischer, 1829) was allowed on the basis of the observed qualitative characters (skull, teeth and skin). The same can be said in the case of *Genetta angolensis* Bocage, 1882 and *Genetta mossambica* Matschie, 1902. These conclusions disagree with those of several recent authors. *Genetta felina* and *Genetta genetta* are considered as distinct species by SCHLAWE (1981), as well as *Genetta genetta* and *Genetta senegalensis* by ROSEVEAR (1974), but the phenotypic differentiations on which these distinctions are based (colour variations and measurements) are

far less sufficient to definitely diagnose them as valid species, like it was suggested by the authors themselves. *Genetta mossambica* has been previously considered as a valid species, and COETZEE (1971) included it in his identification key of the genus *Genetta*. However, the characters used to discriminate *Genetta mossambica* from *Genetta angolensis* are obviously incorrect (for instance, respectively "spots small" and "large spots"; see SCHLAWE's photographs (1981) for illustrated arguments) and probably due to the scarcity of *Genetta mossambica* specimens in Museum collections. Their distinction is also suggested in the identification key of CRAWFORD-CABRAL (1981b), even if the author noticed the great similarity between the habitus of the two "forms".

– on the other hand, the case of *Genetta servalina* is inconclusive as no specimens of *Genetta cristata* Hayman, 1940 were included in this study.

– the distinction between *Genetta pardina* I. Geoffroy Saint Hilaire, 1832 and *Genetta "rubiginosa"* Pucheran, 1855 (see CRAWFORD-CABRAL, 1981a and b; CRAWFORD-CABRAL and PACHECO, 1992), both grouped in the single species *Genetta maculata* (Gray, 1830) by WOZENCRAFT (1993), is confirmed by an important divergence related to cranial characters (GAUBERT *et al.*, in prep.). These considerations, complicated by the fact that *Genetta rubiginosa* is the senior synonym of *Genetta thierryi* (SCHLAWE, 1981; CRAWFORD-CABRAL and FERNANDES, 1999), should involve further nomenclatural modifications (GAUBERT *et al.*, in prep.). But in order to keep the discussion clear, we have chosen to refer to the most commonly accepted nomenclature of the genus (CRAWFORD-CABRAL, 1981b; WOZENCRAFT, 1993).

Secondly, we must specify that some juvenile character states - even present in post-juvenile specimens- can interfere with the identification keys utilisation:

– (1) the sagittal crest is absent, that is to say temporal muscles insertion crests form quite a large area (a similar observation was noticed for the weasel (*Mustela nivalis*) by KING (1980)).

– (2) the curvature of the maxillo-palatine suture's anterior extension is elongated ahead, which can influence the alignment with the P^3 main cusp.

– (3) the coat is generally more densely spotted. Besides, the spots of the first two latero-dorsal rows are often merged so that they constitute two continuous stripes (observations on stillborn specimens of *Genetta servalina* (1996.318 and 319 - NHML)).

Furthermore, this type of observation permits to point out the morpho-anatomical divergence of *Genetta johnstoni* compared to the other genets characteristics, as its adult morphotype presents some juvenile character states like – among others – (1) and (3).

Finally, the *Osbornictis piscivora* metatarsal pads reconsideration shows that morphological observations are still of interest, especially in the Viverrinae subfamily, for which some accurate structure descriptions remain impossible on the basis of current Museum collections (perineal glands, rhinarium, claws recantation system, etc.). Moreover, the presence of distinct metatarsal pads in *Osbornictis* constitutes an additional evidence of its supposed terrestrial way of life (HART and TIMM, 1978; COLYN and GEVAERTS, 1986; VAN ROMPAEY, 1988; KINGDON, 1997), as the organisation and the morphology of its pads are very close to the structural plan of the genet-like taxa (VERON, 1999) and have suffered no important transformations caused by a hypothetical adaptation to aquatic life in river streams. The bare palms of the so-called Aquatic genet only suggest adaptation to fishing activities (HART and TIMM, 1978).

Conclusions and prospects

Although a special attention to "evident" characters has been paid in this determination work, we shall notice that no hand-made identification keys can pretend to resolve every encountered questions of identification. For instance, very similar species, such as *Genetta pardina* and *Genetta "rubiginosa"*, are hardly distinguishable on the basis of coat characters. However, the keys proposed here proved to be a powerful tool in the relabelling of the genets of the MNHN collections.

This preliminary study constitutes a preamble to a cladistic analysis applied to the Viverrinae subfamily, for which the phylogenetic usefulness of the whole character set observed (non reported here) will be tested.

Moreover, the intrageneric delimitation question within the genus *Genetta* will have to be dealt using coupled methods like genetic divergence, caryology, new determination of morpho-anatomical characters and ecological studies.

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