TEMPORAL ONTOGENY IN THE WILD BOAR (Sus scrofa L.*): A SYSTEMIC POINT OF VIEW*

Cousse S., Janeau G., Spitz F., Cargnelutti B.

I.R.G.M., I.N.R.A., BP 27, 31326 Castanet-Tolosan Cedex, France.

Abstract: Fifteen free-ranging wild boars (*Sus scrofa* L.) were studied by biotelemetry in Southern France. Five indicators of activity (circadian and ultradian rhythms, polyphasism, total duration of resting and of movements) were used and their comparison between different categories of animals permitted to describe some ontogenetical differences. Infants and juveniles were characterized by an ultradian and a circadian rhythmicity, adults (except breeding females) only by a circadian one. An important number of activity and resting phases (polyphasism) was observed in young animals and breeding females. Juveniles slept less, moved more and were more diurnal than other animals. The construction of the sleep-wake rhythm was explained by the combination between external (environmental) and internal perturbations in a self-organizing system.

Keywords: Wild boar, *Sus scrofa,* Suidae, Biotelemetry, Activity, Rest, Rhythm, Ontogeny, System, Polyphasism.

IBEX J.M.E. 3:122-125

1. Introduction

Ontogeny means the construction of a young animal (or human) under the action of both internal and external factors, such as maturation and experience (Schneirla, 1966; Gottlieb, 1976; Campan, 1980). Moreover, as said in the title, we consider the individual as a system, more precisely a self-organizing system (Varela, 1989).

Such a system is closed off from its environment; so this environment doesn't provide information but only causes perturbations whose interpretation is elucidated in the system (Varela, *op. cit.*). The new emerging forms, for example a new organization or a new behaviour, result from the interactions between external events considered as perturbations and the internal mechanisms of self-organization.

In free-ranging wild boars, we first compared some biotelemetry indicators between infants, juveniles and adults. This permitted us to deduce some rules about the construction of sleep-wake rhythms in this species. The theoretical approach of self-organization was then used to discuss the results

2. Study area

All the data were obtained in three study areas of Southern France, in the Camargue from 1985 to 1987 and in the Caroux-Espinouse and Montagne Noire massifs from 1989 to 1991. The Camargue is a flat area, with a mediterranean climate; it consists of similar proportions of croplands and marshes, with very small scattered woods and shrublands (Dardaillon, 1984). The two massifs range from 200 to 1200 m u.s.l. with a mediterranean climate influenced by altitude and exposure; their vegetation is diverse (holm oak, chestnut, conifer, various types of heathlands and grasslands; Auvray, 1983; Anonymous, 1979).

3. Material and methods

Fifteen wild boars (Tab. 1) were trapped and fitted with collars containing a double-stage transmitter joined to a mercury switch sensitive to the animal's head position (Janeau & Hachet, 1991). The activity was recorded in real time with a multi-channel biotelemetry system (Janeau *et al.*, 1987). It permitted (Janeau *et al.*, 1991) to distinguish between resting (*sleep*), activity on site and activity with movement (these two last items could be gathered in *wake*).

To study ontogeny, the animals were classified (Spitz, 1992) into (i) *infants* before weaning (ii) *juveniles* from 3 to 8 months (iii) *sub-adults* from 8 to 24 months and (iv) *adults*. Females were divided according to the lapse of time since birth of the piglets; they were considered as an independant sample when breeding infants (*Females with infants*) or with the adult males when breeding juveniles or non breeding (*Other adults*). Results on infants were derived from those of mothers (Cousse, 1994) or were

Table 1: Number of wild boars and biotelemetry sessions for each category of animals. A female could successively belong to the second and third categories of this table.

	Number of different wild boars	Number of 24-h biotelemetry sessions
JUVENILES	5	16
FEMALES WITH INFANTS	6	13
OTHER ADULTS	8	12

Table 2. Characterization of the activity according to categories of animals.

	INFANTS	JUVENILES	FEMALES WITH INFANTS	OTHER ADULTS
Circadian rhythms	?	+	+	+
Ultradian rhythms	+	+	+	-
Polyphasism	+	++	+	-
Total duration of resting	>50%	43%	49%	50%
Total duration of activity with movements	?	33% diurnal	25% nocturnal	36% nocturnal

found in the litterature. Unfortunatly, no data could be obtained on sub-adults.
Five indicators (Tab. 2) were used to describe the activity of the wild boars. They were the subjects of papers which can be consulted for more precision: circadian and ultradian rhythms in Cousse *et al.* (in press), polyphasism (which was calculated by the number of transitions between resting and activity) in Cousse and Janeau (1992), total duration of resting and of movements in Cousse and Janeau (*op. cit.*) and Janeau *et al.* (in press).

4. Results

The presence of a circadian rhythm (Tab. 2) was typical of all studied wild boars (but we found no bibliographical information for infants).
On the contrary, the presence of an ultradian rhythm was characteristic of infants, juveniles and females with infants (Tab. 2). Empirically, all the mean ultradian periods obtained appeared close to a 3-hour interval for the youngest animals and to its harmonics (6 hours, 9 hours and so on) for the oldest animals and for the females (Cousse *et al., op. cit.*). In the juveniles, the ultradian rhythm disappeared around the seventh month. In the females, it disappeared almost immediately after the weaning of the piglets (Cousse *et al., op. cit.*).
The polyphasism was maximal in young animals (10 to 30 transitions, Cousse & Janeau, *op. cit.*) and in females with infants (5 to 30 transitions); it was correlated to several short phases of activity on site inserted in long phases of resting. A progressive decrease of this parameter was observed in females during the breeding period. It was minimal (a single period of resting and a single one of activity) for adult females out of the breeding period and for adult males (Cousse & Janeau, *op. cit.*).
The total duration of resting was the longest in infants (Dallaire *et al.* 1974; Kuipers & Whatson, 1979). After weaning, this duration tended to decrease like in many other young ungulates (Richard-Hansen, 1992). Juveniles slept about fourty percent of the time and the adults about fifty percent (Janeau *et al.*, in press).
Duration of movements was low for infants and for females with infants (Janeau *et al.*, in press). It was greatest for juveniles and for adults (about thirty and fourty percent of the time). Juveniles tended to move during the day-light while all adults were nocturnal. Synchronization with sunset existed for juveniles, but is was less obvious than in adults; on average, they began to move one hundred

minutes before sunset, while the adults began to move only ten minutes after it (Janeau *et al.*, in press).

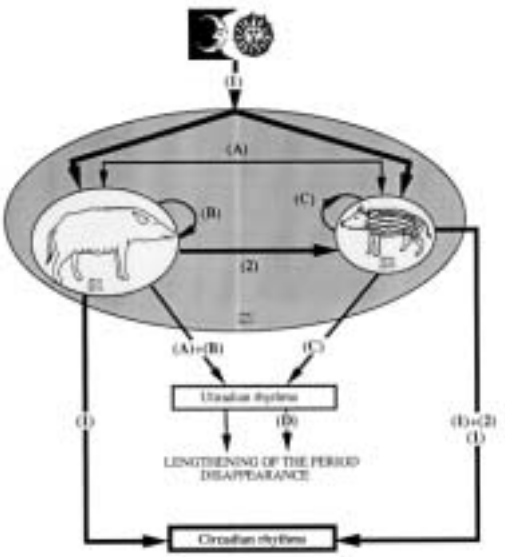
5. Discussion

For the German biologist Ashoff (1963), biological rhythms (circadian and ultradian) are mainly endogeneous. They can adjust to external factors, the Zeitgebers, and then modify their period or their amplitude; the principal Zeitgebers are photoperiod (Ashoff, *op. cit.*), temperature (Hoffman, 1969), food (Reinberg, 1974) and some social features (Gwinner, 1966). The rhythms are also checked by pacemakers, or biological clocks (Boulos & Terman, 1980), which can be considered as autonomous oscillators (Rusak & Zucker, 1975). For example, a rhythmic function, like locomotor activity, can result from the actions of several oscillators, which are coupled or independant.

The biological clock of the circadian rhythm comprises off at least two oscillators (Boulos & Terman, *op. cit.*); the first one is linked to feeding and anticipates the Zeitgeber. The second one is linked only to the photoperiod. For many authors (Hoppenbrouwers & Sterman, 1975; Stone, 1987), the ultradian rhythms come from the desynchronization of several physiological parameters of the organism, among others those linked to the nervous system. They would arise from the immaturity of the organism and wouldn't be subjected to a Zeitgeber.

After birth, piglets stay around one week in the nest (Gundlach, 1968) and their total nutritional dependance creates several correlations between maternal activities and those of the young. This maternal periodic feeding component must be considered as a precocial Zeitgeber for the unweaned animal (Fig. 1). Therefore, the rhythm in piglets would be initiated by the maternal feeding Zeitgeber when they stay in the birth place. It would be supplanted by the photoperiodism when the animals begin to leave the nest (Fig. 1). Both factors would affect the juvenile, a phenomenom which explains the differences observed between age classes in their synchronization with sunset.

According to a systemic point of view, the rhythms are the emergence of the relations between the different levels of the organism. The ultradian rhythms with a fundamental period of 3 hours observed in the youngest wild boars (*system S2* in Fig. 1) would be the first expressions of these co-actions just after the birth. During its development, the animal would be subjected to a series of disorganisations and reorganizations. These would explain the lengthening of the period then the disappearence of the ultradian rhythm. For females with piglets (*S1* in Fig. 1), the addition of internal hormonal perturbations and of external ones, like the presence of piglets and suckling, would cause the emergence of ultradian rhythms (Fig. 1). The disappearance of these perturbations would result in the single circadian attractor.



1: photoperiodic Zeitgeber
2: maternal Zeitgeber
A: suckling and social releasers
B: hormonal modifications
C: non-synchronization
D: maturation

Figure 1. Construction of the individual sleep-wake rhythms.

6. Conclusion

Systemic explanations permit to understand the development of an individual (*S2*) in relation to its environment which includes of course the mother (*S1*). But the ultradian rhythms permit the coordination between the activities of the mother and those of the young. Another systemic point of view is to consider the mother and the piglet as constitutive elements of a new system (*S3*). The ultradian rhythm is

then an emergence of their reciprocal interactions. However, for the Wild boar, it seems more judicious to consider that this new system includes the mother and all the members of the litter.

REFERENCES

ANONYMOUS, (1979) - Itinéraires écologiques et phytogéographiques en Montagne Noire. *Ressources pédagogiques Nationales*, C.R.D.P. Toulouse, 7, 19 pp.

ASCHOFF J., (1963) - Comparative physiology: diurnal rhythms. *Annu. Rev. physiol.*, 25: 581-600.

AUVRAY F., (1983) - *Recherches sur l'écoéthologie du Mouflon (Ovis ammon musimon S. 1872) dans le Massif du Caroux-Espinouse (Hérault) en vue de définir de nouveaux sites d'accueil*. Thèse de Doctorat, Univ. Sciences et Techniques du Languedoc, Montpellier, 176 pp.

BOULOS Z. & TERMAN M., (1980) - Food availability and daily biological rhythms. *Neurosci. biobehavioral Rev.*, 4(2): 119-131.

CAMPAN R., (1980) - *L'animal et son univers, Etude dynamique du comportement*. Privat Bios, Toulouse.

COUSSE S., (1994) - *La construction de l'espace-temps individuel et de l'organisation socio-spatiale chez le Sanglier (Sus scrofa* L.). *Une analyse systémique*. Thèse 3° cycle, Univ. P. Sabatier, Toulouse, 71pp.

COUSSE S. & JANEAU G., (1992) - Time budget and polyphasic activity in Wild boar, *Sus scrofa* L. In : *"Ongulés/Ungulates 91"*, F. Spitz, G. Janeau, G. Gonzalez & S. Aulagnier (eds), S.F.E.P.M.-I.R.G.M., Paris-Toulouse: 391-394.

COUSSE S., QUENETTE P.Y., JANEAU G., LAUGA J. & CARGNELUTTI B., (1995) - Ontogeny of the rest-activity rhythm in the Wild boar. *Z. Saügetierk.*, 60: 143-149.

DALLAIRE A., TOUTAIN P.L. & RUCKENBUSH Y., (1974) - Sur la périodicité du sommeil paradoxal, faits et hypothèses. *Physiol. behav.*, 13: 395-400.

DARDAILLON M., (1984) - *Le Sanglier et le milieu camarguais: dynamique co-adaptative*. Thèse 3° Cycle, Univ. P. Sabatier, Toulouse, 345 pp.

GOTTLIEB G., (1976) - Conceptions of pre-natal development: behavioral embryology. *Psychol. Rev.*, 83: 215-234.

GUNDLACH H., (1968) - Brutfürsorge, Brutpflege, Verhaltens-Ontogenese und Tagesperiodik beim Europaïschen Wildschwein (*Sus scrofa* L.). *Z. Tierpsychol.*, 25: 955-995.

GWINNER E., (1966) - Entrainment of a circadian rhythm in birds by species-specific song cycles (Aves, Fringillidae: *Carduelis spinus, Serinus serinus*). *Experientia*, 22: 765.

HOFFMAN K., (1969) - Temperaturcyclen als Zeitgeber der circadienen Periodik. *Verh. dt. Zool. Ges.*: 265-274.

HOPPENBROUWERS T. & STERMAN M.B., (1975) - Development of sleep state patterns in the kitten. *Exp. neurol.*, 49: 822-838.

JANEAU G. & HACHET T.H., (1991) - Utilisation de la biotélémétrie pour l'étude de l'activité des animaux sauvages. In: *Suivi par biotélémétrie des vertébrés terrestres*, Principauté de Monaco: 133-145.

JANEAU G., SPITZ F., LECRIVAIN E., DARDAILLON M. & KOWALSKI C., (1987) - Système automatique d'acquisition en temps réel et à distance de paramètres biologiques sur animaux en liberté. *Acta Oecol., Oecologia applicata*, 8(4): 333-341.

JANEAU G., COUSSE S. & SPITZ F., (1991) - Activity pattern of Wild boar, *Sus scrofa* L. In: *Proceedings of the 11th International Symposium on Biotelemetry*, A. Uchiyama & C.J.Jr Amlaner (eds), Waseda University Press, Tokyo: 123-127.

JANEAU G., COUSSE S., MANN C.S. & SPITZ F., in prep. - Time-budget of Wild boar, *Sus scrofa* L.: duration of activities, diurnal-nocturnal distribution and synchronization with sunset.

KUIPERS M. & WHATSON T.S., (1979). Sleep in piglets: an observational study. *Appl. anim. ethol.*, 5 : 145-151.

REINBERG A., (1974) - Chronobiology and nutrition. *Chronobiologia*, 1: 22-27.

RICHARD-HANSEN C., (1992) - *Socialisation et modalités d'organisation sociale chez l'Isard (Rupicapra pyrenaica) dans le cadre des théories systémiques et d'auto-organisation, Implications évolutives*. Thèse 3° cycle, Univ. P. Sabatier, Toulouse, 82 pp.

RUSAK B. & ZUCKER I., (1975) - Biological rhythms and animal behavior. *Ann. Rev. Psychol.*, 26:137-172.

SCHNEIRLA T.C., (1966) - Behavioral development and comparative psychology. *Q. Rev. Biol.*, 41: 283-302.

SPITZ F., (1992) - General model of the spatial and social organization of the wild boars (*Sus scrofa* L.). In: *"Ongulés/Ungulates 91"*, F. Spitz, G. Janeau, G. Gonzalez & S. Aulagnier (eds), S.F.E.P.M.-I.R.G.M., Toulouse-Paris: 413-417.

STONE R.D., (1987) - The activity patterns of the Pyrenean desman (*Galemys pyrenaicus*) (Insectivora: Talpidae), as determined under natural conditions. *J. Zool.*, 213: 95-106.

VARELA F., (1989) - *Autonomie et connaissance, Essai sur le vivant*. Seuil, Paris, 255 pp.