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APPLICATION OF RADIO TRACKING TO THE SURVEY OF WILD POPULATIONS OF VERTEBRATE SPECIES (MAMMALS, BIRDS, FISHES) IN BELGIUM

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ABSTRACT

The authors are mainly concerned with behavioral ecology of wildlife animals. The activity of the laboratory was mainly focused on:

a wild mustelid, stone marten (Martes foina), in a suburban environment;

a large game mammal, the wild boar (Sus scrofa), in order to collect basic information needed in management operations;

the red fox (Vulpes vulpes) ecology in order to compare the behavior of normal and rabid animals;

and an endangered bird species, (black grouse, Tetrao tetrix tetrix) and his pattern of land (heather) use after a fire.

All tracking studies were conducted in wooded areas of the southern part of Belgium (Wallonie) from 1976 to 1984. The results are discussed in relation to factors modulating time and space utilization.

*Recently, our laboratory has been developing research programs on eco-ethology and habitat partitioning of freshwater fishes in the River Meuse Basin. First results of a feasibility study of tracking experiments on the barbel (*Barbus barbus*, Cyprinidae) are also presented.*

INTRODUCTION

For more than 200 years, the aim of biologists has been to study and understand animal behaviors. However, the motivations have been slightly changing, slipping from scientific curiosity to a crucial need to understand and know how animals behave, in order to protect man against their "noxiousness" or to preserve them from man's nuisances (best knowledge, best understanding, best protection). In Southern Belgium (Wallonie), a survey of wild vertebrate populations, carried out in the late seventies by scientists from the Zoological Institute of the University of Liège, led to the conclusion that more than 60 percent of vertebrate wildlife species living in Wallonie were endangered, and stated the need for more research aiming at wildlife protection.

Since Cochran and Lord (1963), more than 2,000 tracking and biotelemetry studies have been conducted on more than 500 species throughout the world and tracking has to be considered as a major ecological technique in studying animal behavior, specially as regards nocturnal, erratic or migrating species, which can't be observed easily.

This paper sums up the tracking studies (and associate activities) conducted in Wallonie since 1976 on five target species: 1) the stone marten (*Martes foina* Erx. 1777), a small mustelid whose Belgian geographic distribution has been considerably reduced for 150 years (Libois, 1982), 2) the wild boar (*Sus scrofa* L. 1758), a large game mammal often considered as a major source of nuisance for cultivated fields, 3) the red fox (*Vulpes vulpes* L.), as the main vector of rabies, 4) the black grouse (*Tetrao tetrix tetrix* L. 1758), a small galliform living in small populations in the Belgian "Hautes Fagnes," and 5) the barbel (*Barbus barbus* L. 1758), which is still one of the most abundant cyprinids in Wallonie rivers despite a severe decrease in its populations (Philippart, 1987).

STONE MARTEN

The present study deals with space and time utilization of one adult male individual in a suburban area around Stockay St. Georges (Lat. 50°35' N, Long. 5°21' E) during spring 1983. The animal (1,700 g) was captured in a toppling trap on April 4th, anesthesized with ether (Lockie & Day, 1964), and equipped with a 167 MHz radio transmitter (60 × 12 mm, 40 g, Lithium battery, 900 mAh, expected life: 6 months, Burchard, West Germany) packed in a collar containing a rigid closed loop antenna, as collars seem preferable to harnesses for small carnivores (Cochran & Lord, 1963; Kenward, 1987). Tracking was done nightly with a digital ten-channel receiver and a Yagi antenna (precision 2°) and locations were pinpointed thanks to a light amplificator (Noctron). Radio locations in the field were recorded as distances from known landmarks. Activity rhythms, movements, and home range (determined by Mohr's, 1947, minimum area method) were monitored over an 83-day period from April 4th (capture of the stone marten) to June 25th (transmitter failure).

Figure 3.1a shows an ecological map of the study area around Stockay St. Georges and the radiolocations of the animal over the tracking period, delimiting a 60 ha spring home range. As regards home range utilization, we decided to divide spring into three equivalent periods during which home range size and shape are quite different.

Radiolocations of the stone marten between April 4th and April 26th are summed up in Figure 3.1b. Sixty percent of the total spring home range was used during this period. The animal was mainly found in "natural" habitats (copsewood, waste ground) and in urban areas. No habitat preference could be shown over this period (diversity index (H') = 1.96; equitability (J') = 0.76). During the following period (April 27th–May 28th), only 30% of the home range were used (Figure 3.1c) and most of the activities were focused on a poplar plantation (H' = 0.7; J' = 0.7) which was visited every night and where the animal could eat domestic duck eggs stolen from nearby farmyards. During late spring (May 29th–June 25th), we noticed a sensible shift in the activities and habitats chosen by the stone marten (home range = 50%; H' = 1.46; J' = 0.73), that could be explained, on the one hand by a severe decrease in domestic anatids eggs production and, on the other hand, by the search for a mate.

We identified 6 resting places used by the stone marten during the tracking period. Secondary order resting places were always close to the night activity center and should be considered as temporary raid camps allowing the animal to minimize energetic expenditures when he hunts far from his favorite resting place (G1, 79% of the locations).

Data from 21 complete tracking nights revealed that the mean distance travelled by night was 1250 m (s = 656; range 300m to 2,600m) and that nocturnal excursions duration ranged from 1h20 to 9h00 (m = 6h00; s = 1h22). The animal left his resting place soon after sunset (m = +66 min.; s = 26; range +32 to +145 min.) and returned to it on an average of 77 min. before sunrise (s = 57; range −184 to +30 min.). The activity rhythm pattern of the animal is characterized by an alternance of halts (hiding, hunting, eating) and rapid movements. However, we noticed that, under bad weather conditions, the length and amount of movements were drastically reduced and that the animal spent much more time in temporary resting places. The other major factor that seems to influence the activity of the stone marten is the "feeding success" of the previous night (confirmed by a quantitative and qualitative analysis of faeces of the animal).

As it can be seen from the tracking data, the stone marten develops an opportunistic pattern of habitat use: its foraging activities are not randomly nor regularly distributed: within the home range, several core areas are successively exploited in a way that seems to be linked with their relative food availability.

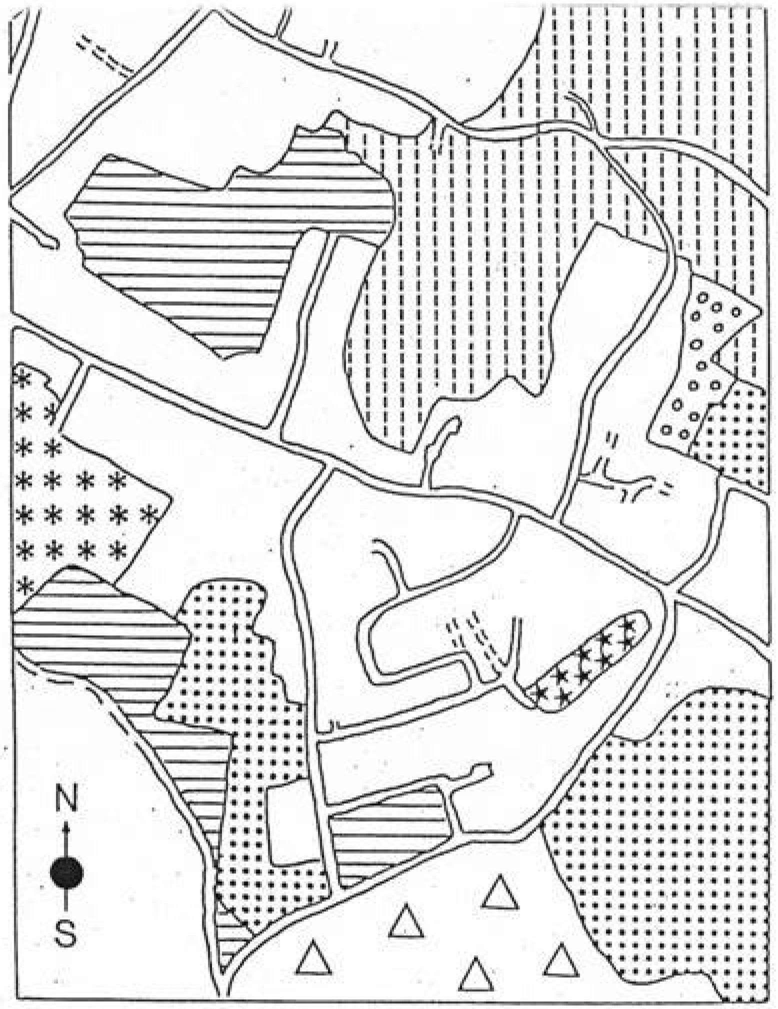


Figure 3.1 Evolution of the stone marten home range during spring 1983 showing on 1:15000 maps of the study area the opportunistic pattern of habitat use. Total spring home range (a). Home ranges and radiolocations of the stone marten in the three main periods of the study, from 04/04 to 26/04, 27/04 to 28/05, 29/05 to 25/06 are illustrated respectively in b, c and d. Resting places are represented by G letters (e.g., G1, G2). (See legend on page 27)

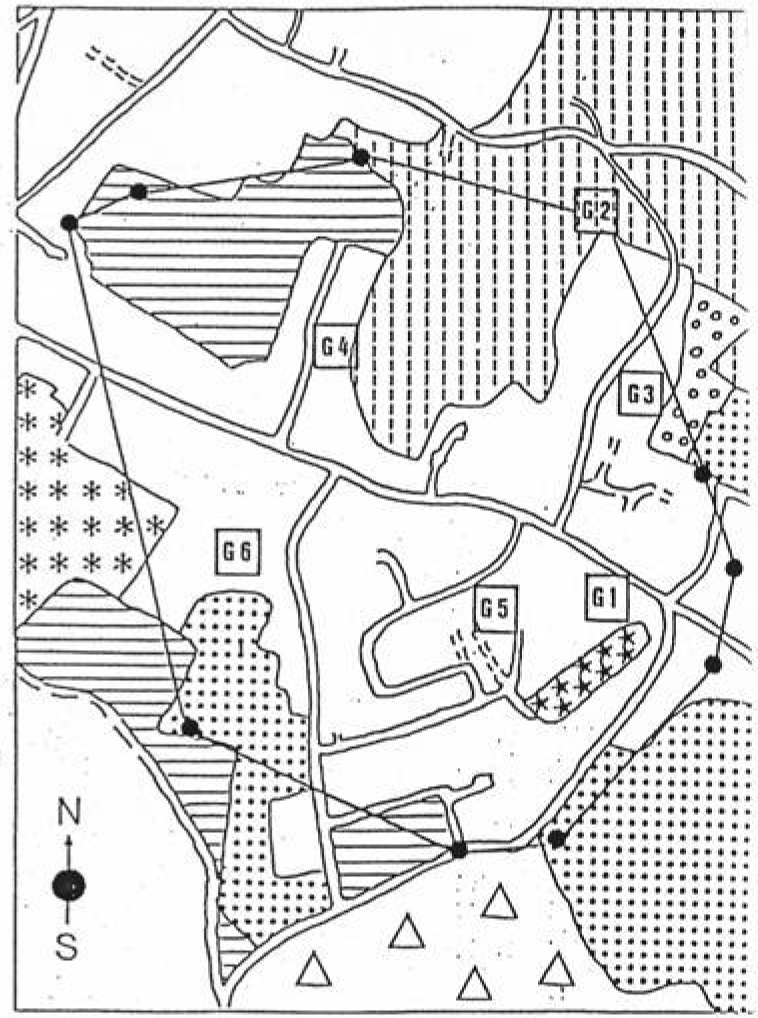
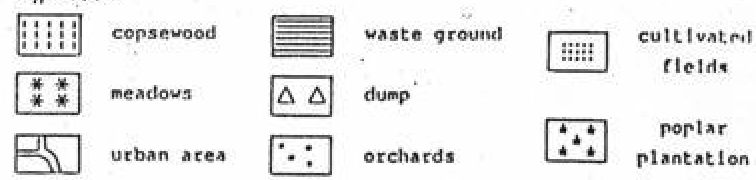


Figure 3.1a



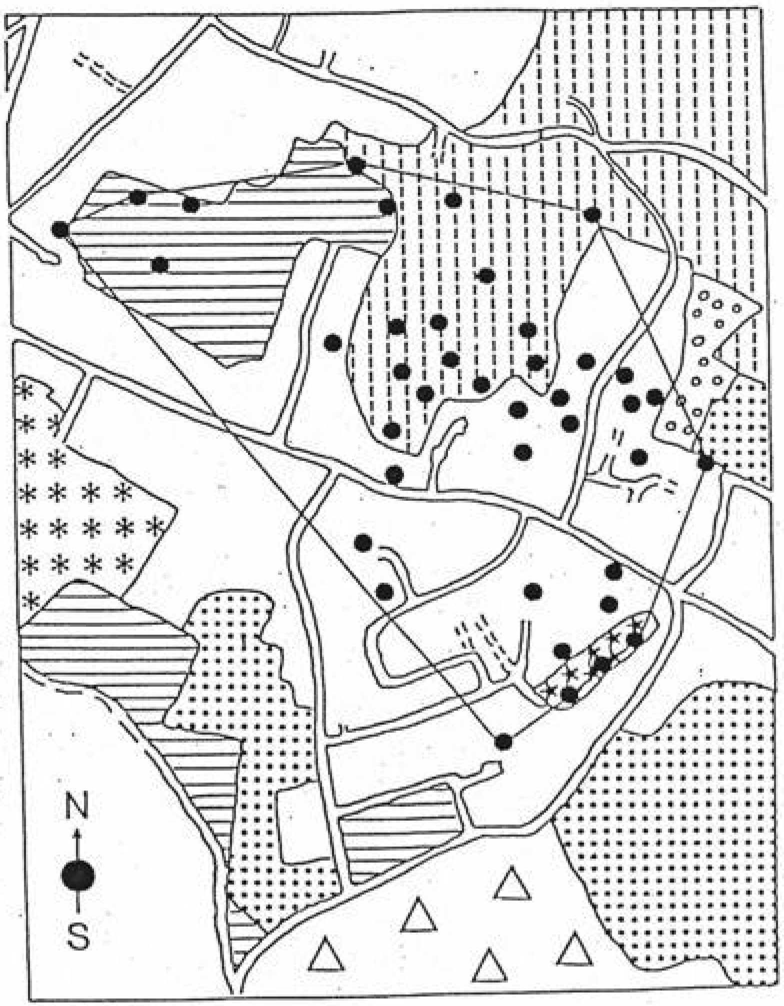


Figure 3.1b

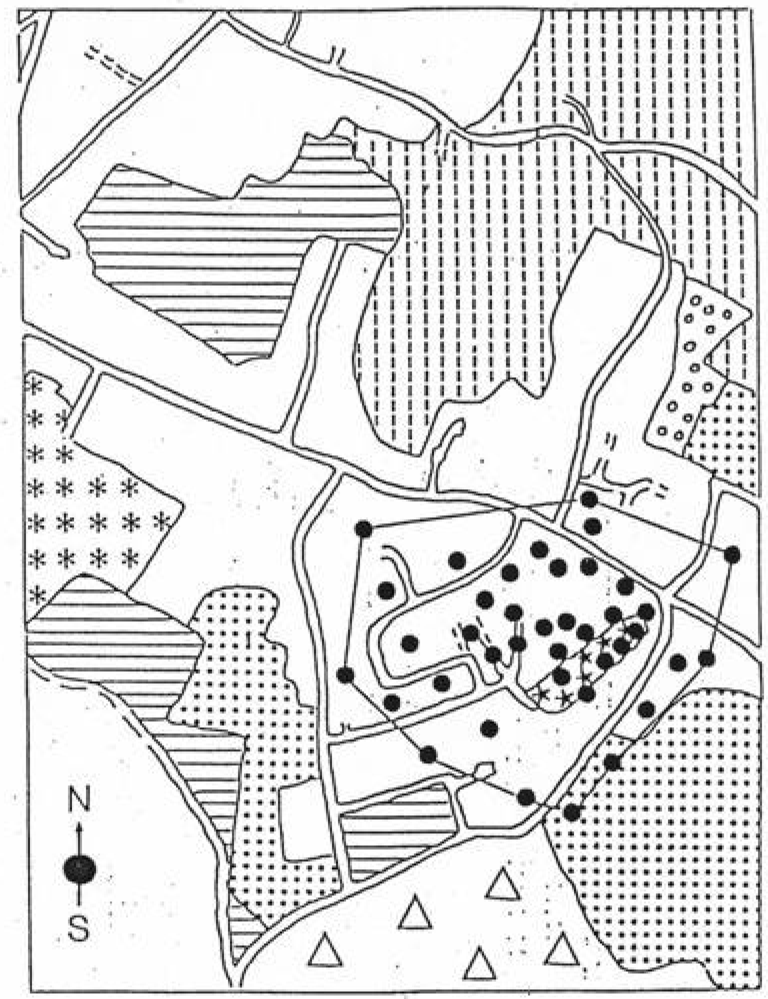


Figure 3.1c

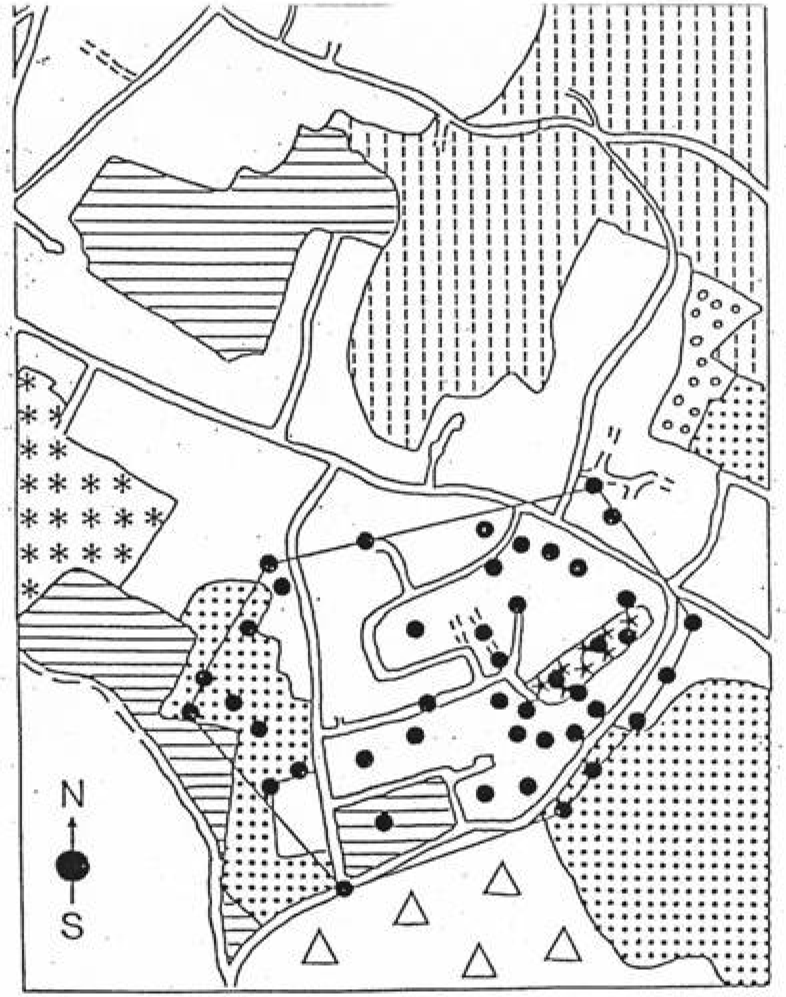


Figure 3.1d

WILD BOAR

This section sums up the results and conclusions of wild boar tracking studies conducted in the forest of Nismes (Lat. 50°01' N, Long. 4°35'E) from May 1983 to April 1984. Three male (30–70 kg) and two female (35–70 kg) individuals, equipped with 167 MHz transmitters (130g; expected life: 34 months), were tracked during this period. Tracking equipment and procedures were similar to those described in the first section.

Time and space utilization in wild boar activity rhythm patterns seems principally influenced by three major factors: 1) climate (seasons and meteorological conditions), 2) man's activities (habitat modifications, feeding, and hunting), and 3) social status.

During summer and spring, when food and cover are easily available, the seasonal home range and movements are reduced when compared to winter (little food and high hunting pressure). Feeding places are also different: deciduous woods in summer vs. coppice, foddering places, and land under cultivation in winter (conifer plantations are almost completely forsaken). Within a season, movements length and mean speed were found to be appreciably reduced under bad weather conditions (fog, heavy rain, gusty wind).

We also noticed that sex and social status played a major part in time and space utilization. Adult males are principally "solitaires" and live in a wide seasonal home range (> 500 ha), resting in thicket zones and feeding in copsewood. However, old males travel smaller distances and move more slowly than females and younger males living within a herd (respectively 4 km/day at 0.89 km/h vs 4.85 km/day at 1.13 km/h). Sows live in smaller overlapping home ranges although the presence of young individuals in summer often leads a sow to extend her home range (from 150 to 650 ha) and to move faster (3.5 km/h).

Taking into account these results derived from radio tracking data could help biologists and administrators to reduce boars' erraticism, and subsequent damages caused to crops, by controlling regularly boars populations, slowing down conifer replantations (as coniferous woods represent a minor feeding habitat for boars), protecting deciduous woods, and increasing foddering places during food shortage periods.

RED FOX

In 1984, during a study conducted on post-juvenile dispersion of young foxes in the woods of Sart-Tilmant, we had the opportunity to capture a six-weeks-old rabid female. The fox was equipped with a 167.200 MHz radio transmitter collar and tracked from June 18th to September 8th, using equipment and procedures described in the first section.

In the daytime (resting period), the fox was mainly located in coppice and covery; whereas, nighttime activity centers were always close to urban areas (gardens, meadows, roads). The home range increased almost in an exponential way during the study period: 7 ha on July 18th, 14 ha on August 8th, and 48 [illegible] October 8th. During the following days, the transmitter couldn't be detected anymore but our study fox was observed twice close to human habitations in the daytime and was found shot on October 12th in a garden near Rotheux, 10 kms ahead from the limit of its previous home range.

Our results differed significantly from post-juvenile dispersion patterns of "normal" foxes living in similar habitats (mean distance travelled during dispersion: 2 kms) (Lloyd, 1980) and of adult rabid foxes. Andral et al. (1982) never noticed major movements out of the home range while tracking 6 adult rabid foxes. In conclusion, it seems that rabies influences differently young and adult individuals, modifying repartition within the home range as regards adult foxes and increasing dispersion distances for juveniles but this hypothesis should be confirmed by future tracking study on rabid foxes.

BLACK GROUSE

This study deals with time and space utilization of two male black grouse during the moulting period in the Belgian "Hautes Fagnes," near Jalhay, soon after a fire (April 29th). The birds were equipped with homemade 75 MHz radio-transmitter collars (55g) and tracked from two towers with a Yagi null peak system from May to August, 1976.

The home range over the study period averaged 42.5 ha (15% of the "Grande Fagne de Jalhay"). Two main activity periods could easily be identified: at dawn (3:30–7:00 AM) (visit to the arenas) and at the end of the afternoon (4:00 PM to 7:00 PM). The grouse's daily activities were always focused in small zones (0.5 ha) and movements ranged from 300m to 750 m a day. The animals were found to stay in "wooden" areas within the burnt zone (80% of the locations).

The presence of black grouse in a burnt habitat was quite unexpected as the almost complete destruction of the heather layer didn't allow them to find hiding places on the ground. Our results differed significantly from those of tracking studies carried out in Scotland from October, 1967, to May, 1968 (Robel, 1969): mean home range: 447 ha (vs 42.5 ha); area of concentrated use (75% of the locations): 88 ha (vs 37.5 ha). Several factors could explain these differences. First, the size of the study area and of the grouse populations were different. Moreover, our grouse didn't belong to the same subspecies as Robel's ones (*Tetrao tetrix tetrix* vs *Tetrao t. britannicus*) and lived at different latitudes and under different climatic conditions. However, the preponderant factor is probably the season during which tracking operations were carried out (October-May vs May-August); the animals being less active (two 3-hours periods of activity) during the moulting period. This hypothesis could help us in explaining a sensible increase of grouse's home range in late August.

BARBELS

For thirty years, biotelemetry has been extensively used to monitor movements, activity rhythm patterns of captive and free-ranging animals. While

wildlife biologists can often visually observe their study animals for transmitter effects, fisheries researchers haven't the same opportunity. In reviewing underwater biotelemetry literature, we noticed that transmitter attachment methods (stomach insertion, surgical and external implantation) can adversely affect fish (reduction of swimming ability, modification of predator-prey relations, survival rate, tag retention, growth); so evaluations of tagging procedures have to be done before starting tracking operations and to extrapolate results with confidence to a larger group of untagged animals.

To this end, we conducted laboratory experiments to evaluate the effects of external and surgical attachment procedures on the barbel (*Barbus barbus*, L.), testing for survival, growth, behavior of dummy radio tagged vs. control barbels, healing, and tag loss.

Experiments were conducted on 5 groups of barbels (140g–1,400g) reared at the CERER (Tihange, Belgium) in a 2,000 L (2 × 2 × 0.5m) flow-through PVC tank where fishes were fed daily with commercial trout pellets. Cylindrical dummy transmitters (2.8g–25g) were constructed of 4-components epoxy resin. Transmitter size, shape, and weight simulated proportions of commercially available transmitters and were designed to weigh 1–2% of the fish weight out of the water. Fishes were anesthesized in a 20 l container with a 100 ppm MS-222 solution at 14–20 °C with dissolved oxygen maintained above 6 ppm. External attachment method was applied on 16 barbels. In the first group ("Saddle," n = 8, 31/03/1988), transmitters were attached dorsally with a side-saddle harness (± 2g) in about 4 min. Two 0,5mm nylon 15-kg-test monofilament attachment wires were passed in a syringe needle through a rubber pad, fish muscles and rubber pad-plastic plate opposite the transmitter, and half stitches secured the wires to the plastic plate (cf., Mellas & Haynes, 1985). In the second group ("Tandem," n = 8, 30/04/88), the rubber pads-plastic plate harness was replaced by a small (2g) epoxy dummy transmitter. Surgical implantation procedure was similar to that used by Hart and Summerfelt (1975), opening a midventral incision between the pelvic girdle and the anus. A sterilized (alcohol) transmitter was inserted into the coelom and the incision was closed with interrupted sutures placed 5–8mm lateral to the incision and through all levels of the bodywall. Three types of suture materials (3-0 and 2-0) were used: long-term resorbable polyfilament, Dexon (n = 7, 01/04/88), non-absorbable monofilament Flexocrin (n = 8, 01/05/88) and short-term resorbable material, catgut (n = 8, 11/06/88). Fishes were checked every day for survival and tag loss and every 5 to 10 days for weight and healing.

Catgut material was resorbed (or torn out) on a average of 7 days (4–10 days) while fishes belonging to the "Dexon" group lost their suture filaments within the first day (knots were found loose, then untied). However, the 22 surgically implanted fishes were alive at the end of the study, none of them did expel his dummy transmitter, neither through the lumen of the intestine nor through the incision, and no fungal nor bacterial infection could be seen during the study period. As regards healing, the muscle layer was closed up sooner in fishes sutured with Flexocrin (m = 18 days) and with catgut (m = 20 days) than in fishes that lost Dexon suture material (m = 32 days) but complete healing (including cicatrization of the bodywall) was achieved more rapidly in catgut and Dexon groups (respectively 42 and 45 days after transmitter implantation) than in the Flexocrin group (54 days). These differences could be explained on the one hand by the major part played by sutures during the first days and on the other hand by the strong irritation caused by the presence in the healing zone of permanent suture material.

External attachment was proved less reliable than intraperitoneal implantation: 6 of the 8 barbels from the "Saddle" group died within the first 20 days, when exposed to thermal gradient (14–19 °C) and low oxygen levels, while surgically implanted barbels seemed unaffected. The two surviving fishes were still alive at the end of the study period but one of them had lost his transmitter on day 84. No mortality was observed in the "Tandem" group but 5 fishes had broken the attachment wires and lost their tags (on days 42, 52, 56, 62, 69). All externally dummy radio tagged barbels had enlarged holes (1–5 mm) in the skin and muscles around the attachment wires and several rows of scales were eroded by the rubber pads of saddles.

Figure 3.2 shows the evolution of radio tagged barbels weight during the study period. We noticed a sensible weight loss (3–5.5%) in all groups during the ten first days. Further controls allowed us to show a significant difference between short-term resorbable (or lost) suture groups (Dexon and catgut) increasing their weight from the tenth day and, on the one hand, fishes sutured with Flexocrin, unchanging their weight (94.3% of their initial weight) during a 40 days period, and on the other hand, externally dummy radio tagged barbels (up to 10% of weight loss on day 60).

In conclusion, by testing different attachment methods and suture materials, with all factors taken into account, surgical implantation closed up with short-term resorbable material represents the best method to attach transmitters to barbels.

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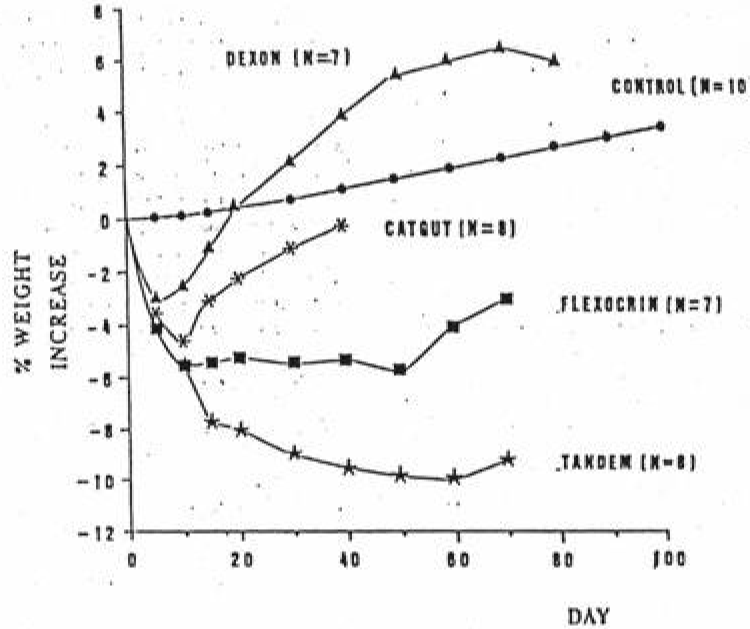

Figure 3.2 Evolution of dummy radio tagged barbels weight showing significant differences between surgically implanted and externally tagged fishes (the date of transmitter attachment is considered as day 0).

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