Conservatoire de l'espace littoral et des rivages lacustres

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L-AWTORITÀ TA' MALTA DWAR L-AMBJENT U L-IPPJANAR

Petites îles de Méditerranée

SITE OF COMINO (MALTA): Eradication of the Black Rat ; WHY? IS IT POSSIBLE? IS IT URGENT?

Petites îles de Méditerranée 07

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MOTS-CLES :

Malte, Comino, rat noir, souris grise, lapin de garenne, dératisation, protocole, herpétofaune, *Rattus rattus*, *Mus musculus*, *Orychtolagus cuniculus*,

RESUME :

L'île de Comino se caractérise par une activité humaine relativement localisée. L'avifaune de l'île est très pauvre en espèces, alors que l'herpétofaune se distingue par sa richesse en particulier, à travers d'importantes populations de *Podarcis filfolensis* et de *Chalcides ocellatus tiligu*.

D'autre part, cette île abrite une importante population de lapins de garennes *Orychtolagus cuniculus*, de souris grises *Mus musculus* et surtout une population de rats noirs Rattus rattus, dont on ignore l'abondance et les réels impacts de sa présence sur l'écosystème de Comino. Les menaces potentielles des ces trois mammifères allochtones et notamment le rat noir, demeurent pesantes et ceci en raison de la mauvaise réputation de ces trois espèces et de leur impact négatif sur le fonctionnement des écosystèmes d'accueil, particulièrement dans le cas des écosystèmes insulaires.

Il convient cependant de relativiser l'action d'élimination de ces rongeurs et particulièrement celle de l'éradication du rat noir, vu l'absence de réelles mesures de l'impact de leur présence sur la faune et la flore de cette île et notamment avec une avifaune quasi-absente, une herpétofaune en abondance et une flore caractéristique (garrigue) qui semble être en bon état de conservation.

Toutefois, l'option de l'éradication de la population de rats noirs de Comino est réalisable, malgré sa grande superficie (> à 100 ha) et ses formations géomorphologiques qui en rendent l'accès difficile (falaises, substrat calcaire diaclasé, formations karstiques, grottes etc…) qui compliquent la mise en œuvre de cette action.

OBJET:

Report of the mission carried out in Malta from May 14th to 17th, 2008 by Michel Pascal within the framework of the third edition of " the Initiative for the Small Islands of the Mediterranean " (PIM) organized by " the Academy of the coast and Lake Spaces (Conservatoire du littoral et des Espaces Lacustres) (CEL).

A) OBJECTIVES OF THE MISSION

There are excerpts from the report prepared by Mr. Sebastien RENOU and Mr. Sami BEN HAJ (Conservatoire du Littoral) at the end of the preliminary mission carried out between February 25th and 29th 2008 and specifically concerning the Comino Island:

1°) Study of the major threats (rats, rabbits, touristic pressures …)

2°) Study of the feasibility of an eradication of the population of rats

This report focuses essentially on the second point. It will be necessary to use the following information with precaution, because of the brief stay on the island (less than 15 hours in two days) and the scarcity of the documentation we had.

B) SOME PHYSICAL AND ECOLOGICAL CHARACTERISTICS OF COMINO ISLAND

This island of 270 hectares consists exclusively of limestone rocks. An important part of its coastline is fringed by breaked cliffs with many cavities and caves, some having an outlet submarine.

Most of the vegetation of the island consists of a pillow of halophile scrubland (phrygana) of *Thymbra capita*, *Anthyllis hermaniae*, *Helicrysum melitense* and *Brachipodium racemosum* with *Astericus aquaticus*, *Cynara cardunculus* (wild artichoke) and *Urginea pancratium*. The latter species is that whose extracts of the bulb were used by the Romans as rodenticid. Its active ingredient is that of the current swiss scilirosid rodenticid preparation. Some tree species have been introduced in restricted number (Aleppo pine, Eucalyptus, Tamaris, Acacia, …), but the bulk of introduced plants belong to non-woody species and are clustered in the vicinity of the hotel and its bungalows (see in particular the important nursery located between the hotel and the blue lagoon, which has many specimens of Carpobrotus, Aloe and cactus, among others).

This island was inhabited and frequented by human for a long time, and available summary of archeological, historical and archaeozoology would be very useful to a based perception of the historical contingency behind the composition and functioning of the various ecological habitats of the island.

Currently, human activity is relatively located on Comino : the site of the hotel and its bungalows, the Blue Lagoon, which daily receives a large contingent of boats and tourists, the site of the former sanatorium which hosted for a full year three families of farmers and the ex-industrial pigsty.

C) THE MAMMALIAN POPULATING OF COMINO ISLAND

No animal of packsaddle or stock was observed in nature. According to an inhabitant of the island, the industrial pigsty lodged, during our stay, only a single band of 4000 pigs. No obvious trace of the presence of carnivores (dogs, cats, weasel …) has been found.

A large population of rabbit (*Oryctolagus cuniculus*) occupies the island. These small rabbits have a light beige coat made of long and silky hair. Many young animals were found dead with no trace of aggression and without clear manifestation of myxomatosis.

A line of 18 trapping posts, each consisting of a Manufrance folded rat trap and of an INRA trap, was put along the way leading from the hotel to the bungalows. The traps were laid on the 14th of May and checked in the morning of 15th and 16th May. Seven trappings posts were set on the 14th of May in immediate neighboring of bungalows and controlled on the 15th. Seven trapping posts were established along the exterior walls of the pigsty on the 14th and 15th of May and were controlled on the 16th (see "Data Comino" 2008 annexed in the report).

The taking into account of the dysfunctions which made traps inoperative makes it possible to establish that the effort of trapping made by means of the Manufrance rat traps rises with 35-night traps and allowed a capture of a single black rat (*Rattus rattus*) on the site of pigsty and an ocellated skink (*Chalcides ocellatus tiligugu*) amputed from its tail and the major part of its members. The 43-night traps realized by means of INRA traps allowed the capture of three house mouses (*Mus musculus*) including one on the site of pigsty, and of *C. oscellatus* in good state. Many cones from *Pinus halepensis* were found gnawed by *R. rattus* on the route leading from the hotel to the bungalows.

No Ectoparasites was detected with the direct examination of the captured rodents. Their autopsy revealed that the adults of the two species were in reproduction. The black rat had a liver probably parasitized by a trematode and the stomach of one of the mice contained 7 nematodes of a big size (see "Data Comino 2008" annexed in the report).

The parasites were collected and sent to Benoît Pisanu[1]. The latter identified the parasites infesting the domestic Mouse as *Mastophorus muris* (Gmelin, 1790) and added the following comment: " *it's about*

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a cosmopolitan nematode, diheteroxene (an intermediate host and its definitive hosts), which parasitizes the stomach of Muridae, with a tropism for the subfamily of Murinae. We find it at Apodemus spp., Mus musculus, Rattus spp. (and in particular R. rattus of "Basse Terre" (Guadeloupe Island) to note that M. muris has been confused for a long time with Protospirura muris), Calomys spp., but also in Clethrionomys glareolus (but not in other Arvicolinae).

An intermediate Hexapode is necessary for the complete development of this nematode. It could be a Coleopter, an Orthoptera, a Blattere, a Diptere (Phlebotom) or even a Siphonaptere !!! Hence the cosmopolitanism of this taxon… (See Anderson, 1992)".

A tissue sample was taken from each of the captured rodents in order to allow an eventual subsequent determination of the subspecies.

The weak effort of sampling in terms of night traps and propected habitats and the limited numbers of captures do not allow to make the general conclusions concerning the abundance and the spatial distribution of the two species of rodents whether on the local natural history of theses species (cycle of reproduction among other) or on the nature and the local importance of the impact which they have on native plants and animals.

D) NATURALISTIC OBSERVATIONS

a - The avifauna

What follows requests a possible confirmation from the Maltese ornithologists of the expedition. I did not make any systematic observation on the avifauna and therefore they are general impressions caused by the direct observation and by discussions on the spot with people of the group (i.a. S. Renou).

Despite the apparent excellent capacities of reception, the marine and terrestrial avifauna of the island is very poor in individuals and species (some partridge couples, *Alectoris* sp., hybrid pigeons, *Columbia livia*, blue-rock trush, *Monticola solitarius* and spectacled warbler, *Sylvia conspicillata,* and one individual of yellow-legged gull, *Larus michaellis*).

b - The herpetofauna

The island accommodates beautiful populations of *Podarcis filfolensis* and *Chalcides ocellatus tiligugu*. Two specimens of the

latter species were captured, one in a INRA trap, the other in a rat trap. This observation confirms those made last year on the Habibas islands (Algeria) and this year on the Galite island (Tunisia) : the INRA trap and/or the bait used here to catch micromammals (agglomerate of peanut butter, flakes of oats and sardine oil) is particularly attractive for this species.

At the end of the day of 15 May, they were small specimens of gecko *Hemidactylus turcicus* were found under entangled stones in the vegetation of the plateau situated between the Blue Lagoon and the hotel.

On May 16th, late morning two big size *Tarentola monticola* were observed in one of the external walls of the pigsty and two beautiful specimens of the melanic form of *Hierophis viridiflavus* were observed : one in a heap of stones at the foot of an external wall of the pigsty, the other in a bush of canes situated about twenty meters from the previous one.

C- The fauna of invertebrates

I did not make any systematic observation on the fauna of invertebrates, but I collected some specimens of Tenebrionides during the herpetologic survey conducted on the plateau situated between the Blue Lagoon and the hotel. Theses specimens were sent to Laurent Soldati[2] for identification.

E) POTENTIAL THREATS OF ALLOCHTONE MAMMALS ON THE LOCAL FLORA AND FAUNA

The wild mammalian fauna contacted during this visit comprises three species, all alien to the island and probably introduced from a long date: the Wild rabbit, the Black rat and the House mouse. To make sure that this fauna does not comprise other species, including autochtones or endemic, an inventory operation more sustained and systematic should be conducted.

Whatever happens, the three allochtones species observed are all famous to have a significant impact on the functioning of their ecosystems of reception mainly when it is about insular ecosystems.

In the Mediterranean zone, the control or the eradication of the Black rat increased to a significant degree the success of reproduction of the Cory's shearwater *Calonectris diomedea* (Thibault, 1995; Igual and *al.,* 2006 ; Pascal and al., 2008 ; Ruffino and *al.,* 2008). Its presence reduces the abundance of storm

[2] INRA/UMR CBGP (1062) Campus International de Baillarguet
CS 30016 MONTFERRIER SUR LEZ cedex

petrel (*Hydrobates pelagicus*), even made disappear some of its population and would prevent its re-settlement (Ruffino and *al.,* 2008). Following the eradication of the Black rat of the Lavezzu Islands (Corsica, France), the number of nesting couples of Marmora's warblers (*Sylvia sarda*) has greatly increased and this result is to put a connection with the multiplication by 7, 3 and 2 of the number of the nesting couples of Rock Pipit (*Anthus petrosus*), of the Winter wren (*Troglodytes troglodytes*) and of the Dunnock Accentor (*Prunella modularis*) from the island of Trielem (Bretagne, France) four years after the eradication of the Norway Rat, *Rattus norvegicus* (Kerbiriou and *al.,* 2004). The eradication of the domestic rabbit of the Ile Verte (Kerguelen Archipelago, sub-Antarctic) allowed its spontaneous recolonization by 2700 plants of the subantarctic crucifer *Pringlea antiscorbutica* in 8 years (Chapuis and *al.,* 2004). The examples could be multiplied and all show that the introduction of theses species has always had a significant impact on the ecosystems which accommodate them.

It is advisable however to relativize the subject by locating it within the framework of a global project of restoration of the habitats and the current settlement of the animals and plants of the island of Comino. Rats and mice cannot have any impact on avian settlement which is virtually absent. The relative abundance of the species of herpetofauna lets suppose that the impact of rodents on them is limited. Finally, the apparent good health of the scrubland lets suppose a reasonable impact from the population of wild rabbits. These conclusions should be relativized because they are based on a single short-term observation made at a particular time of the annual cycle and do not contain any knowledge about the historical dynamics of the animals and plants of the island.

It is probable that some management operations of another type except that of the elimination of allochtone species of mammals will immeditaly have faster beneficial consequences and at lower cost. Assuming that the eradication of the two species of rodents is considered, the main result to be expected would not concern the populations of currently present species on the island but the possible installation of bird species which are currently absent (i.a. the Cory's shearwater (*Calonectris diomedea*), the yelkouan shearwater (*Puffinus yelkouan*), and Storm Petrel (*Hydrobates pelagicus*).

F) FEASIBILITY OF THE ERADICATION OF THE POPULATION OF R.RATTUS OF THE ISLAND OF COMINO.

A recent synthesis (Howald and *al.,* 2007) counts all the insular eradication attempts of Muridae (Black rat, *R. rattus*, Norway rat, *R. norvegicus* ; Pacific rat, *R. exclans* ; House mouse, *Mus musculus*), conducted on a global scale in a stated aim of protecting the local fauna and flora. This synthesis counts 332 successful attempts, 35 failures and 20 operations of which we ignore the success or failures. The successes involved 284 islands with a total area of 47 628 ha. The most ambitious operation to this date has resulted in the eradication of the population of the Norway rat on an island of 11 300 ha (Campbel, New Zealand ; Mc Clelland and Tyree, 2002).

The number of successful operations against the only Black rat amounts to 159. Fifteen failures were recorded. The largest island in which an operation to eradicate the Black rat was conducted successfully represented an area of 1022 ha. (Hermite island, Australia ; Burbidge, 2004).

In France, five attempts to eradicate the insular populations of Black rat were performed on Natural reserves. None has been the cause of side effects so far. The oldest was successully carried out by the Office de l'Environnement de la Corse in 1990 on Toro island (0,9 ha ; Cerbical) by the chemical method (Lorvelec and Pascal, 2005). Four attempts were made using the detailled method by Pascal et *al.,* (1996) which consists in the successive use of trapping and chemical control. Three of them were successful: i) in 2000, eradication of the Black rat population on the Lavezzu island and its 17 peripheral islets, the initiative was conducted by the Office de l'Environnement de la Corse (respectively 73 and 12 ha. ; Lavezzi Archipelago, Corsica ; Pascal and *al.,* 2008); ii) between 2000 and 2002, four islets of the Natural Reserve of Sainte Anne islets (Martinique, 5,8 ha ; Pascal and al., 2004); iii) and, in 2005, population of Plane island on the initiative of the Conservatoire-Etudes des Ecosystèmes de Provence (15,2 ha Riou Archipelago Natural Reserve). The simultanous attempts to eradicate the Java Mongoose (*Herpestes auropunctatus*), the Gray mouse and the Black rat of Fajou island (117 ha of mangrove, 3 ha of dry forest; Natural Reserve of Grand Cul-de-Sac Marin, Guadeloupe) showed the success of the eradication of the Mongoose and the failure of the elimination of the Black rat. This failure is attributed to the arboreal behaviour of the specie which occupies the canopy of mangroves, rarely moves on waterlogged earth and therefore escaped the trapping and the toxic baits (Lorvelec and *al.,* 2004). The virtual absence of a tree-planted stratum prevents this source of failure on Comino.

Howald and *al.,* (2007) conclude their synthesis in these terms : given the currently available tools, the eradication of commensal rodent populations of the isalnds whose area is less than 100 ha is achievable by a competent team of environment managers. The

surface of Comino is largely higher than 100 ha and its important cliffs just like its substrate diaclase limestone and karst formations seriously complicate the implementation. Its programming and execution could only be undertaken by a team of specialists in the current state of available knowledge and techniques.

G) METHODS OF THE POSSIBLE ERADICATION OF RODENTS OF THE ISLAND OF COMINO

a- Choice of the strategy of eradication

An initial question of importance which the manager must answer: two alien species of the rodents are present on the island now, the Black rat and the domestic mouse. Should we consider the eradication of the only Black rat or the two species? Indeed the eradication of the only Black rat is likely to have important consequences on the population of domestic mouse. For example, three years after the eradication of the Norway rat of an island in the Archipelago of Cancale (Brittany, France; Pascal and *al.,* 1996) its population of domestic mouse showed a demographic explosion whose consequences have not been quantified for lack of original data, and Canta and *al.,* (2007) mentioned eight examples of demographic explosion of the Grey mouse following the eradication of the insular *Rattus* populations. The methods of eradication will notably change according to what is considered the eradication of the only *Rattus* or that of the two species of rodents.

The strategic choices relate to the technique or techniques of eradication, their mode of application and the calendar of their implementation. These choices are modulated by the geography and climatology of the site, the local biology of the targeted species, that of autochtone species and the objectives of the manager.

The technique available to fight against animal and plant species are of three kinds: biological, physical or chemical. The choice may be made on one or another of these techniques or a combination of several of them.

To this day, no specific pathogenic agent of rodents and likely to cause the disappearance of one of their population has been discovered. In addition, work on the immunocontraception has not succeeded yet. It is among other reasons that the biological fight against the rodents is not currently permitted in Europe (Pascal, 1993).

The developed chemical fight against rodents uses acute toxins (active matter) or which have a different effects. The use of acute toxins is banned by the European legislations. The only toxins currently allowed are anticoagulants which are toxins of different effects.

In Europe, their use in nature is subject to conditions, and for the majority of them are with authorization. Two molecules were used as a priority during the European operations for the eradication of rodents: the chlorophacinone and the bromadiolone. If the chemical fight is used on the island of Comino, I would suggest the use of the bromadiolone.

These toxins are incorporated according to a concentration imposed on baits of variable constitution. The easiest formulation consists in coating seeds of cereals by an only concentrate of the active matter. I prescribe the use of this formulation in the context of Comino Island because of the presence on the island of the granivorous animals and the yellow-legged gull (*Larus michahellis*), species likely to consume these baits and die. Another type of formulation is the pellet, an extruded cylinder of agglomerate of crushed cereals and of active matter. This formulation is less dangerous for the local avifauna than the previous one, is the one used in case of application by air. A third type of formulation of the waterproof cobblestones which is an agglomerate crushed cereals and of active matter drowned in an inert matrix, in general paraffin. This formulation has the double advantage of producing baits which are not consumed by the avifauna attracted by the cereals and resisting the bad weather in a significant way. As a result, these baits remain palatable longer than those mentioned above. This formulation is particularly adapted for the manual application.

Eradicating a population of rodents by traps is possible, but requires a massive and constant pressure of trapping for a month or more. This method has the interest to be able to track in real time the dynamics of the disappearance of the individuals of the targeted species. Its also allows a complete collection of georeferenced information on the targeted population. The information collected so far on the use of this technique of eradication includes the morphology , the reproduction, the diet, the parasitology (Pisanu, 1999 ; Pascal and *al.,* 2005 a), bacteriology (Michel, 2001), the genetic and social structure (Abdelkrim and *al.,* 2008), even, on the mechanisms of microevolution at work (Abdelkrim and *al.,* 2005 b). If the use of this information is of interest for the fundamental research, it is not deprived of it for the manager. It allowed, among other things, to show the relevance of the use of molecular genetics to decide whether to proceed or not in an eradication (Calmet and *al.,* 2001; Abdelkrim et *al.,* 2005 a) or to determine the causes of eradication's failure (Abdelkrim and *al.,* 2007). It is this technique coupled with a terminal chemical fight that we have developed and employed in a thirty eradication of insular populations of rodents and carnivores (Lorvetec and Pascal, 2007). On the environmental level, it has the advantage of reducing by 90 % the risk of indirect poisoning of non targeted species, the trapping allowed in 12 days the capture and in consequence the withdrawal of 90 to 100 % of the individuals of the targeted species. However, despite the usefulness of this method, it is not the one that I would proscribe for the island of Comino because

would be difficult to implement successfully on this site due to the steep feature of its relief and the calcerous and faulted nature of its sub-soil.

It is therefore the use of the chemical fight that I would like proscribe for the site of Comino. Such a decision is however subject to the locally regulations in force.

The distribution of toxic baits can be done in three modes: manual distribution in flight, manual distribution on bait posts, air distribution by a helicopter.

The last mode of distribution, developed by New Zealanders, is both the fastest and least expensive in labour. It assumes, however, to have specific equipment and specialize pilot the helicopter must be equipped with a distribution hopper adapted to the type of pellet used to obtain the desired concentration of baits per unit area and this in a homogenous way on the entire area of the island. In addition, the treatment of many sub-vertical surfaces of the coastline of the island requires the use of a helicopter whose blowing turbine is substituted for the tail rotor. This turbine is equipped with a hopper and projects pellets on the horizontal. A specialized New Zealand company performs such operations on an international scale.

The manual distribution in flight requires a perfect Knowledge and mastery of places in order to spread the baits on all the sites occupied by the rodents and within a period of time not exceeding tow days. Tow spaced application between 6 to 10 days as a minimum. Generally and for safety we proceed to a third application, except there is a proof of its uselessness.

The distribution on posts of baits has four advantages, that to be able to follow the progression of the disappearance of the rodent by following that of baits, that of limiting the availability of baits for possible non-targeted species, that to offer baits a protection against bad weather and finally that to facilitate the withdrawl of non-consumed baits in the end of the operation. These posts can be made of segments of 40 cm of PVC pipe (gutter descent type) which will each receive two paraffin blocks of 50 g. It is recommended to fasten these blocks to the PVC tube by wire in order to counter a possible behavior of storage without consumption by the rodent. The tubes are put according to level curves and distant of 20 to 30 m from each other.

The best period of the annual cycle to proceed to an eradication of the rodents by the chemical way is the period of food shortage which generally corresponds to a stop of reproduction. During this period, there are no young in the nest that are unfit for the consumption of baits and likely to survive after the early disappearance of their mothers and the rodents are more inclined to consume the baits than at any other times of the year. The eradication of the population of the Black rats of Lavezzu (Corsica, France) took place during the month of

October. On this occasion, 1342 Black rats were captured and 1338 of them were autopsied. Among these latter 691 were females. None of them was pregnant or nursing. The eradication of the population of the Black rats of the Plane island (Riou Archipelago, France) was conducted in August and led to the capture of 784 rodents which were all autopsied. Only two of the 339 females was pregnant and none was nursing. The period August-October would correspond to that required for the Mediterranean region.

The time of the implementation of the eradication should also take into account the important disturbance caused by the operation. The opinion of ornithologists in this respect is highly wished in order to refine the limits of this period. Finally the success of the operation also depends on the weather conditions, especially if the distribution is done by air. The time course of the operation should therefore correspond to a period of the year benefiting of mild weather conditions (absence of rain and wind).

b) **Possible collateral effects of the chemical fight**

The chemical fight can generate two harmful effects on the environment: the direct poisoning of non-targeted species by consuming toxic baits and the indirect poisoning of non-targeted species through the consumption of the corpses of poisoned rodents.

The recommended anticoagulants have no effect on the fauna of invertebrates and have a very limited and not really shown to this day in nature on the fauna of ectotherm vertebrates, and are active on the homeotherm vertebrates. The mortality induced in the homeotherm vertebrates is of dependent dose and varies according to species. For the mammals for example, in addition to the rodents, the most sensitive species are the boar (*Sus scrofa*), the dog (*Canis lupus*) and the horse (*Equus ferus*). These risks of direct and indirect poisoning are the most important when the duration of exposure to baits or to toxic corpses is longer. It is one of the two reasons which leads to recommend brief and intense operations increases their chances of success.

From our brief inventory of the non-flying mammalian fauna, the natural environment of Comino only hosts currently two rodents and the wild rabbit. This latter species is very sensitive to anticoagulant. Moreover, it is not excluded that the island hosts a localized population of limited number of the Lesser Shrew (*Crocidura suaveolens*) and/or of the Etruscan Shrew (*Suncus etruscus*). In the 4 to 10 years which followed the eradication of the Norway rat of the islands of the Seven Islands Archipelago in Brittany (France), the index of the abundance of the Lesser Shrew has multiplied by a factor of 7 to 25, according to the island and the year of control. Furthermore, the spatial distribution of the species, initially very localized, covered almost all the islands 4 years after the eradication. The same result was observed for a

second species of the Lesser Shrew *C.russula* (Pascal and *al.,* 2005 b).

The extrapolation of these results on Comino Island, keeping in mind that it is here about the *R.rattus*, not the *R.norvegicus*, suggests that the absence of the capture of the Lesser Shrew during this mission does not necessarily mean their absence on the island. Indeed, on the one hand, the trapping effort was modest, one the other hand, all the habitats were not inventoried.

The second taxon of present invertebrates on the island and sensitive to anticoagulants is that of birds. The use of the waterproof cobblestones reduces the risk of consumption by granivorous animals and the yellow-legged gull.

This risk will be further reduced if the period of eradication corresponds to that of the absence of these species from the island (the Rock pigeon (*Columba livia*) and the yellow-legged gull, among others). On the Comino Island , the risk of indirect poisoning concerns possible big raptors. This risk should be reduced by the brevity of the operation.

c) To perpetuate the possible success of eradication

A recent publication, abundantly quoted, reports the spontaneous crossing of an arm of sea of 400 m by rodent (Russel and *al.,* 2005). It was a Norway rat, not a Black rat. The first species, original of northern China, is reputed to be the best swimmer and more resistant to cold temperature than the second which is original of the Indian sub-continent and has a much better ability of climbing than the first which explains its arboreal behaviour in the tropical zone.

Indeed no founded data at the present time makes it possible to assess the distance which a Black rat is likely to go spontaneously in sea. However, the distance which separates the Comino Island from the neighbouring lands appears to be sufficient to consider a spontaneous reinfestation of the island as negligible.

In return, the intense traffic of people and goods presents an important risk of reinfestation. Reducing this risk will require to adjust the landing sites and to establish rules for packaging (container) and " unpacking " of goods and construction materials (operations in closed place).

Finally, it will be desirable to set up a permanent device of trapping posts and baits intended to intercept the rodents landing on their arrival on the island (Pascal et al., 2008). These posts are set close to the shore on the most favourable portions of the coast for landing. Such a device has already permitted the interception of the landing of *Rattus* on the Lavezzu island in 2005 (J.M. Culiolo, com.pers.).

H) CONCLUSIONS

The eradication of the population of the Black rats of Comino island is achievable. If it is undertaken, it will be a major operation requiring the mobilization of a big team of specialists and substantial financial resources.

Before undertaking it, it will be necessary to identify and establish the means to perpetuate the possible success of the operation.

Before undertaking it, it should also be necessary to identify the variables which should represent the object of the follows up in order to determine whether expected results of this operation of management are met or not.

Rennes May 28th, 2008
Michel PASCAL

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ANNEX1: PROTOCOL FOR INFORMATION COLLECTING ON MICROMAMMALS AND FIELDS NOTICE OF AUTORSY FILES (EXCEL) ASSOCIATED WITH EACH LAND OPERATION.

(Version of February 26th, 2008) by M.P)

Localization of trapping

a) Archipelago

b) Island

c) Town

d) Fragment: When they are identified. For lack, the type of trapping: line, quadrat, random etc…,

e) Environment: rancker, dune, aerohaline lawn, shrub formation, mangrove etc…,

Chronology

f) Day (D)

g) Month (M)

h) Year (Y)

Identification of the trap

i) Number of the trap in the device (NT)

j) Type of trap (TT): Inra, R (rat trap), Sh (Shermane)

k) GPS positioning of the trapping posts

Identification of the individual and of the species

l) **Number of identification of the individual (N) :** it is the one which was attributed to it when the trap was removed (cf. Trapping file) and the one which will follow all the observation and samples collected on the animal.

m) **Identification of the species (Sp):** by convention and as long as there is no possible confusion, the first letter of the genus associated to the first letter of the species are used. For example: Rr = *Rattus rattus*, Rn = *Rattus norvegicus*, Mm = *Mus musculus*, As = *Apodemus sylvaticus*, Cs = *Corcidura suaveolens*, Cr = *Corcidura russula*, etc….

Morphometric measurents

n) **Full weight in grams (Pds P or Pds if not Pds V):** Without looking for a precision superior to one or 2 g (a full bladder of *Rattus* is of 5 g and I do not mention the stomach and possible foetus). The use of a battery kitchen scale is easier and more pressure on the field than the balances.

O) **Empty weight in grams (Pds V**): Weight of the carcass done after the removal of all the digestive tract and possibly of the urine. Concerning the pregnant females, removal of the uterine horns.

p) **Head and body length in mm (Hbl)** : All the measurements were done in flat back, on a board where we pitched two spaced points of the average diameter of the tail of the examined species (Often two sets of nails : one for the *Rattus,* the other for the other micromammals, generally much smaller). A small ruler makes it possible to measure the length between the points and the vertical muzzle.

q) **Length of the tail in mm (Lt):** Length between the points and the extremity of the tail. This measurement is systematically eliminated for the individuals whose tails were cut or broken.

r) **Length of the foot in mm (Lf):** length measured between the a plomb of the heel and the extremity of the longest finger. Do not take into account the length of the nail.

s) **Length of the ear in mm (Le):** length measured by a small ruler between the notch of the base of the ear and its extremity.

Observations on the reproduction

t) **Sex:** 1=male, 2=female

u) **Length of the testicle in mm (Lt):** by diameter of the testicular oval.

v) **Length of the epididyme (Lt):** Length of the developed epididyme (its possible regression will be mentioned in not).

w) **Number of embryos in the right uterine horns (NEr)**

x) **Number of embryos in the Left uterine horns (NEl)**

y) **Average diameter of foetal bulbs in mm (D.foet)**. Possibly, we note, the number of atresic foetuses.

z) **Sex of the foetuses (Sx foet):** n m, n' f for n males and n' for females.

aa) **Number of placental scars in the right uterine horns (Npsr)**.

bb) **Number of placental scars in the left uterine horns (Npsl).**

cc) **Number of yellow bodies in the right ovary (Nybr).**

dd) **Number of yellow bodies in the left ovary (Nybl).**

ee) **Number of albican corpora in the right ovary (Nacr).** Rarely possible.

ff) **Number of albican corpora in the left ovary (Nacl).** Rarely possible.

gg) **Nursing (Nu) :**1=yes ; 0=no.

Parasitism

hh**- Ectoparasitism (Ecto):** Number of siphonapteres (n Sph) or of ticks (nt).

ii) **Endoparasites (Endo):** presence in direct examination=1; absence=0.

jj) **Localization of endoparasites (Endo.Loc):** Lung=P ; general cavity = Gc ; esophagus = Oe, stomach = St, Caecum = Cc, digestive tract = Dt, etc.…

Nutrition

KK) **State of the stomach repletion (Est):** Full=1; then 3/4, 1/2; 1/4, empty = 0.

ll) **Superficial examination of the stomach content (S.est) :**

V= vegetation ; I=invertebrates, etc…

Sample taking

mm) **Taking a sample of tissue for the needs of the works of molecular genetic (Genet) :** they are systematically made except in exceptional cases. Phalanx or entire finger conserved in a tube holding the number of the individual and containing 10 times of the volume of the sample of alcohol 90°. Conservation in freezer – 20°C. Yes=1: No=0.

nn) **Taking samples for the needs of the works of systemic morphology (Systé) :** Sample taken in the light of circumstances. Taking a sample of the entire carcass or only of frozen stored skulls or in alcohol 70°C. Yes=1; No=0.

oo) **Taking a sample of blood (bP) :** made for the needs of bacteriology or virology. The blood is normally taken on the field by intracardiac puncture or under orbital according to needs. The entire blood is preserved in a heparinized tube, but generally we proceed by decantation or centrifugation in the separation of the serum which is stored at – 20°C. Yes=1; No=0.

pp) **Sample taking of eyeballs. (Age):** done to determine individual age therefore when a follow-up of population or the establishment of a prescise age is considered.

The eyeballs are preserved in 10 times their volume of diluted formol at 10 % and stored at room temperature (20°C) for a minimum of 3 months before dissection, dessication then individual weighing. Yes=1; No=0.

qq) Sample taking for the needs of mass spectrometry (Spectro) : Yes=1 ; No=0.

rr) **Type of sample taking for the spectrometry (T.spectro) :** liver = L ; muscle = M ; bone = bone ; tooth = (tth).

SS) **Sample taking to study the diet and the endoparasitory fauna (Reginae):** the entire digestive tract will be removed and stored either at – 20°C or in alcohol 90°. Yes=1; No=0.

ANNEX 2:

A-Trapping

N	Archipelago	Island	Date	Day	month	year	landscape	Nr. Post	INRA	Rat trap
1	Malta	Comino	15/05/2008	15	5	2008	Phrygana	1	.	.
2	Malta	Comino	15/05/2008	15	5	2008	Phrygana	2	.	X
3	Malta	Comino	15/05/2008	15	5	2008	Phrygana	3	.	.
4	Malta	Comino	15/05/2008	15	5	2008	Phrygana	4	.	.
5	Malta	Comino	15/05/2008	15	5	2008	Phrygana	5	.	.
6	Malta	Comino	15/05/2008	15	5	2008	Phrygana	6	.	.
7	Malta	Comino	15/05/2008	15	5	2008	Phrygana	7	.	.
8	Malta	Comino	15/05/2008	15	5	2008	Phrygana	8	.	.
9	Malta	Comino	15/05/2008	15	5	2008	Phrygana	9	.	*C.o.*
10	Malta	Comino	15/05/2008	15	5	2008	Phrygana	10	.	.
11	Malta	Comino	15/05/2008	15	5	2008	Phrygana	11	.	.
12	Malta	Comino	15/05/2008	15	5	2008	Phrygana	12	.	f
13	Malta	Comino	15/05/2008	15	5	2008	Phrygana	13	.	.
14	Malta	Comino	15/05/2008	15	5	2008	Phrygana	14	.	f
15	Malta	Comino	15/05/2008	15	5	2008	Phrygana	15	.	.
16	Malta	Comino	15/05/2008	15	5	2008	Phrygana	16	.	.
17	Malta	Comino	15/05/2008	15	5	2008	Phrygana	17	.	.
18	Malta	Comino	15/05/2008	15	5	2008	Phrygana	18	.	.
19	Malta	Comino	15/05/2008	15	5	2008	Phrygana	19	.	f
20	Malta	Comino	15/05/2008	15	5	2008	Phrygana	20	.	.
21	Malta	Comino	15/05/2008	15	5	2008	Phrygana	21	.	f
22	Malta	Comino	15/05/2008	15	5	2008	Phrygana	22	.	.
23	Malta	Comino	15/05/2008	15	5	2008	Phrygana	23	X	.
24	Malta	Comino	15/05/2008	15	5	2008	Phrygana	24	.	.
25	Malta	Comino	16/05/2008	16	5	2008	Phrygana	1	.	X
26	Malta	Comino	16/05/2008	16	5	2008	Phrygana	2	.	.
27	Malta	Comino	16/05/2008	16	5	2008	Phrygana	3	.	.
28	Malta	Comino	16/05/2008	16	5	2008	Phrygana	4	.	.
29	Malta	Comino	16/05/2008	16	5	2008	Phrygana	5	.	.
30	Malta	Comino	16/05/2008	16	5	2008	Phrygana	6	.	.
31	Malta	Comino	16/05/2008	16	5	2008	Phrygana	7	*M.m.*	.
32	Malta	Comino	16/05/2008	16	5	2008	Phrygana	8	*C.o.*	.
33	Malta	Comino	16/05/2008	16	5	2008	Phrygana	9	.	f
34	Malta	Comino	16/05/2008	16	5	2008	Phrygana	10	r	.
35	Malta	Comino	16/05/2008	16	5	2008	Phrygana	11	r	X
36	Malta	Comino	16/05/2008	16	5	2008	Phrygana	12	.	f
37	Malta	Comino	16/05/2008	16	5	2008	Phrygana	13	.	.
38	Malta	Comino	16/05/2008	16	5	2008	Phrygana	14	*M.m.*	.
39	Malta	Comino	16/05/2008	16	5	2008	Phrygana	15	.	.
40	Malta	Comino	16/05/2008	16	5	2008	Phrygana	16	.	.
41	Malta	Comino	16/05/2008	16	5	2008	Phrygana	17	.	.
42	Malta	Comino	16/05/2008	16	5	2008	Phrygana	18	.	f
43	Malta	Comino	16/05/2008	16	5	2008	Phrygana	25	.	f
44	Malta	Comino	16/05/2008	16	5	2008	Phrygana	26	.	.
45	Malta	Comino	16/05/2008	16	5	2008	Phrygana	27	.	.
46	Malta	Comino	16/05/2008	16	5	2008	Phrygana	28	*M.m.*	f
47	Malta	Comino	16/05/2008	16	5	2008	Phrygana	29	ar	X
48	Malta	Comino	16/05/2008	16	5	2008	Phrygana	30	f	*R.r.*
49	Malta	Comino	16/05/2008	16	5	2008	Phrygana	31	.	f

Clé : X : inoperative ; f : closed ; a : disappeared bait ; r : reversed ; . : RAS

M.m : *Mus musculus* ; *R.r* : *Rattus rattus* ; *C.o* : *Chalcides ocellatus*

B-Autopsy

Archipelagol	Isalnd	Date	Day	month	Year	Sp	Np	Nr	Pds	Ltc	Lq	Lp	Lo	Sx	Dt	Dv	Nfd	Nfg	Ncpd	Ncpg	Ncjd	Ncjg	Al	Chip	Tick
Malta	Comino	16/05/2008	16	5	2008	*Rr*	48	1	157	.	.	.	.	2	.	.	0	0	3	5	0	8	1	0	0
Malta	Comino	16/05/2008	16	5	2008	*Mm*	7	2	15	.	.	.	.	1	SA	SA	.	.	.	.	.	.	.	0	0
Malta	Comino	16/05/2008	16	5	2008	*Mm*	14	3	14	.	.	.	.	1	SA	SA	.	.	.	.	.	.	.	0	0
Malta	Comino	16/05/2008	16	5	2008	*Mm*	28	4	21	.	.	.	.	2	.	.	0	0	99	99	99	99	1	0	0

Archipelago	Island	Date	Day	month	Year	EndoLiver	EndoStomach	EndoFine Intestine	Obs parasites	Stomach	Stomach Contents	Obs morphology	Obs fattening	Obs reproduction	Ren
Malta	Comino	16/05/2008	16	5	2008	Trematode	0	0	.	0,00	.	.	.	.	
Malta	Comino	16/05/2008	16	5	2008	0	0	0	.	0,00	.	.	.	.	
Malta	Comino	16/05/2008	16	5	2008	0	0	0	.	0,00	.	.	.	.	
Malta	Comino	16/05/2008	16	5	2008	0	Nematodes	0	Stomach. Full. Sample	0,00	.	.	.	.	