Coconut crab monitoring programme

Data collection protocol

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Motivation: Why collect coconut crab data

The coconut crab (*Birgus latro*) is found on numerous oceanic islands and atolls in the Indo-Pacific region (Figure 1). However, as a result of over-exploitation and habitat degradation their numbers are declining over much of the region (Fletcher *et al*. 1990a, Schiller 1992). The Indian Ocean population has been the worst hit and is now largely confined to three populations centred on the Aldabra group of atolls, the Chagos Archipelago and Christmas Island (Lavery *et al*. 1996). On Aldabra Atoll the coconut crab benefits from complete protection, a situation which could provide important baseline data for management plans developed to ensure a sustainable harvest in areas where the crab is exploited. The IUCN lists the coconut crab as Data Deficient, i.e. data on abundance and/or distribution is lacking (Eldredge 1996).

Figure 1. Global Distribution of the coconut crab (*Birgus latro*) (Wikipedia).

Alexander (1976) identified several important ecological roles of the coconut crab on Aldabra: as scavengers they remove rotting material and so reduce the number of carrion breeding flies, they help to decompose leaf litter, distribute coconuts and other seeds, particularly figs, provide a food source for birds in the juvenile stage and in turn influence the populations of crab species upon which they prey. They also contribute to soil aeration and erosion through their burrowing activity (Alexander,1976).. It is clear that they play an important part in the island ecosystem.

Coconut crabs are also significant with regard to their evolutionary history. They have specialised adaptations to terrestrial living, showing a fascinating life-history that links terrestrial to oceanic transitions; following the planktonic larval stage, juveniles bear characteristics reminiscent of hermit crabs during early developmental stages and adults are entirely terrestrial. Human population growth, subsequent exploitation and habitat transformation have been described as some of the main threats to the coconut crabs. Aldabra Atoll is therefore an important refuge for this species. Alien invasive species such as rats (present on Aldabra) and yellow crazy ants *Anoplolepis graciplipes* (not present) have also been associated with coconut crab population declines in other areas, and therefore warrant population status monitoring.

Brief history of coconut crab monitoring on Aldabra

Coconut crab monitoring on Aldabra was initiated in 2006 by Dr. P. Pistorius, the then Research Officer (RO). The initial monitoring was done weekly around the Picard research station, and on a monthly basis around camp huts (e.g. Cinq Cases, Anse Mais and Malabar) and existing transects. The initial aim of the study was to establish:

- Changes in abundance of coconut crabs in relation to season.
- Relative densities of coconut crabs in different vegetation types, in relation to distance from the coast, and between the four main islands of Aldabra Atoll.

- Absolute population estimate for Aldabra Atoll
- Population structure of the coconut crab on Aldabra
- Relative growth rates in relation to vegetation type
- Movement patterns within Picard Island

A mark-recapture study was set up (mostly confined to Picard) that attempted to determine differing growth rates in relation to vegetation type, and movement patterns within the island. Crabs were captured and uniquely marked. Crabs were marked on an opportunistic basis, and then resighted during the monthly transect surveys.

A highly significant positive exponential relationship between weight and thoracic length was established in 2006 by Pistorius (Annual RO report 2006; Figure 2), which corresponds with findings from other studies (Amesbury 1980, Fletcher 1990b). The correlation between these two variables negates the need to record weight, as thoracic length is a reliable proxy for weight. The thoracic length is the linear distance between anterior and posterior borders of the thoracic groove (see Figure 3). This is the linear measurement least subject to measurement error or to variation caused by damage to the crab (e. g., broken rostrum).

Following the departure of Pistorius in mid-2008 the data collection programme was downscaled both in terms of localities and parameters. In the current programme (2008 onwards) data is collected on a bimonthly basis from two transects on Picard, namely the Back Path (BP) and the Coastal Path (CP).

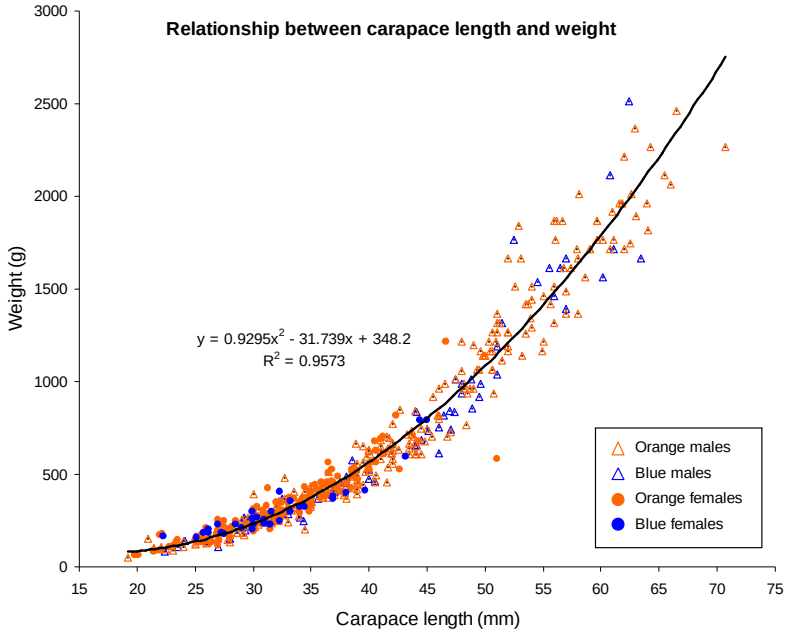

Figure 2. Relationship between carapace length and weight in robber crabs at Aldabra. (Aldabra RO Annual report 2006)

Basic species information

The coconut crab or robber crab, *Birgus latro* L., obtained its name from its reputation of stealing nuts from coconut trees (hence the specific name *latro* which is Latin for "robber"). They belong in the Phylum *Crustacea*, Class *Anomura*, Family *Coenobitidae*, which includes most of the land-based hermit crabs. *Birgus* is a monospecific genus because *B. latro* is the only member of the group which, as an adult, dispenses with the general hermit crab trait of protecting its abdomen with an empty gastropod shell. Instead, the abdomen is tucked partially underneath the body and is protected on the dorsal surface by a

series of hardened tergal plates (Figure 3). The remainder of the abdomen is covered with a leathery skin bearing tufts of small bristles. Two distinct colour morphs, blue and orange, occur on Aldabra. Reports about the size of coconut crabs vary, and most references give a maximum weight of up to 4kg, a body length of up to 400mm, and a leg span of around 1m, with males generally being larger than females. They can reach an age of up to 30–60 years. The body of the coconut crab is, like all decapods, is divided into a front section (cephalothorax), which has 10 legs, and an abdomen. The front legs have massive claws used to open coconuts and these claws (chelae) are also used for lifting objects. The next three pairs of legs have smaller tweezer-like chelae at the end and are used as walking limbs. These specially adapted limbs enable the coconut crab to climb vertically up trees. The last pair of legs is very small and serves only to clean the breathing organs. These legs are usually held inside the carapace in the cavity containing the breathing organs (Fletcher 1993).

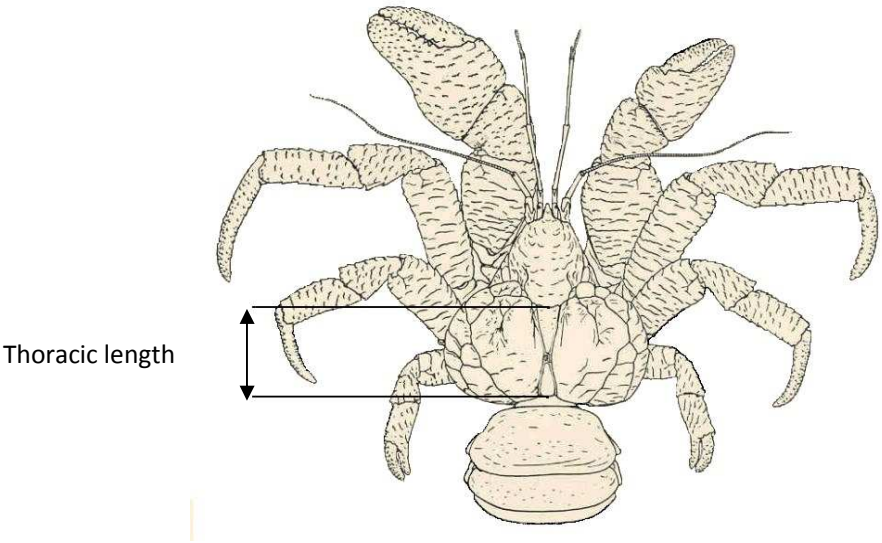

Figure 3. Measurement of thoracic length.

Unlike juvenile coconut crabs, that use salvaged snail shells to protect their soft abdomen, adults do not carry shells. Instead, they harden their abdominal armour by depositing chitin and chalk. The hardened abdomen protects and reduces water loss on land, but it needs to be moulted at periodic interval. Moulting takes about 30 days during which the animal's body is soft and vulnerable. During this period the animal stays hidden for protection.

The mating procedure takes about 15 minutes. First, the male and the female fight with each other and eventually the male turns the female on her back to mate. After mating the females move towards the shore probably before the eggs are extruded. Immediately after extrusion, the bright orange fertilized eggs are attached "like bunches of grapes" to the three pleopods on the abdomen (see Figure 4). Schiller et al., (1991) found that egg maturation took between 25 and 45 days with the difference directed at synchronising the time of spawning (all females deposit their eggs at the same night(s)). During this period the berried females usually remain in crevices and burrows within 100 m of the shore often at higher than normal densities (Schiller et al., 1991). When the larvae in the eggs are fully developed the female walks down to the water's edge, ensuring that the egg mass does not come in contact with the water. When it reaches the ocean it either reverses and places its abdomen in the water or waits for a wave to wash over it. Larval release occurs within a few seconds and is usually aided by a vigorous shaking of the abdomen (Hicks et al., 1984; Reese 1987; Schiller et al., 1991). When released in the ocean these larvae are called zoeas.

Figure 4. Female coconut crab with eggs underneath her abdomen.

The zoeas drift in the ocean for 28 days during which a large number of them is eaten by predators. Afterwards they live on the ocean floor and then on the shore as 'hermit crabs' using empty shells for protection for another 28 days. They change their shell as they grow, similar to true hermit crabs. They lose the ability to breath in water after they leave the ocean permanently. About 4–8 years after hatching the coconut crabs mature and can reproduce. This is an unusually long development period for a crustacean. Their diet consists largely of fruit including coconuts. However, they will eat nearly anything organic including leaves, rotten fruit, tortoise eggs, dead animals and the shells of other animals which are believed to provide calcium. They also eat alive animals that are too slow to escape such as freshly hatched sea turtles. Coconut crabs often try to steal food from each other and will pull their food into their burrows to be safe while eating.

Coconut crabs can cut holes into coconuts with their strong claws and eat the content. This behaviour is unique in the animal kingdom. A special technique has been developed to open coconuts. It starts by stripping the husk always beginning from the side with the three germination pores (the little group of three small circles on top of the nut). Once the pores are revealed the crab will attack one of them until it breaks. Then it uses its smaller pincers to extract the coconut flesh. The claws of larger individuals can even break the hard coconut into smaller pieces for easier consumption (Fletcher 1993, Amesbury 1980, Alexander 1976).

Coconut crabs live alone in underground burrows and rock crevices. They dig their own burrows in the sand or loose soil. During the day they stay hidden to protect themselves from predators and to reduce water loss from heat. While resting in burrows the coconut crab closes the entrance with one of the claws to create the moist microclimate within the burrow necessary for its breathing organs to function. In areas with large coconut crab populations, some individuals may also come out during moist or rainy days since these conditions allow them to breathe more easily.

Frequency of monitoring and location

Monitoring is conducted bimonthly on the island of Picard after sunset simultaneously on the Coastal Path (CP) and Back Path (BP) transects. One transects is monitored by two persons (4 in total) and the monitoring typically takes 1 to 2 hours.

Picard CP: points 12 to 40 (the abundance of coconut crabs around settlement is unnatural and points 1 to 12 are not done because of this reason).Picard BP: points 0 to 40

Equipment

Headlamp with enough power (take spare batteries if not sure), callipers, pen/pencil and recording form (where are these saved?) (or field notebook as you say below), clipboard presumably needed for surface?

Methodology

The transect counts are performed by two people of whom at least one is trained and has experience with the method and the specific transect. In general one of the two writes down the data while the other catches and examines the coconut crab to gather information and both are equipped with headlamps. Each transect is divided into 50m sections and during a traverse, all coconut crabs found within 5m to either side of the centre line are recorded by section and estimated distance from the centre line.

Measurements / information

Information requirements are indicated in the data collection form shown in Table 1. It is important that vigilance is maintained throughout the transect, because small coconut crabs may be partially or completely covered by shrubs or tall grasses, or lie hidden in the crevices in the champignon.

The data are recorded on the form or in a field notebook and later transcribed on a form. The following data are required for each crab: coconut crab # (pre-filled), transect section #, distance from path (m), thoracic length (mm), sex, moult stage, colour morph and notes.

Table 1. Datasheet

COCONUT CRAB TRANSECT RECORDING FORM

day / month / year

DATE: _____ **TIME - Start: _____** **TIME - finish: _____**

TRANSECT: _____ **RECORDERS: _____**

CLOUD COVER (%): _____ **WIND:** calm - light - moderate - strong *(encircle)*

RAIN: dry - raining - wet ground from previous rain *(encircle)* **MOON:** zero - 1/4 - half - 3/4 - full *(encircle)*

#	**Location** between marker poles:	**Distance** from path (m)	**Thoracic length** (mm)	**Sex** (male / female)	**Moult Status** (1-4)	**Morph** (orange / blue / unk)	**Comments** (tags, tag location, eggs / activity etc)
1							

Recorders should identify themselves with full names to avoid subsequent confusion with abbreviations. All the variables stated on the field form are required for all live coconut crabs encountered along each transect and should be recorded on the data collection form, as explained in detail below:

#:

The writer should allocate a consecutive number to each coconut crab as it is recorded along each transect, e.g., the first (1), tenth (10), etc. Note that on the present form these are pre-entered.

Location:

For each encountered coconut crab the full section identifier should be recorded, i.e. section: "0–1". "19–20", "29–30", etc.

Distance

For each encountered coconut crab the estimated distance to the centre line of the transect should be recorded to the nearest metre, i.e. 0, 1, 2, 3, 4 or 5 meters.

Thoracic length

The thoracic length in millimetres is measured with callipers as shown in Figure 3.

Sex

Female crabs are readily identified by the presence of three large, feathery legs (pleopods) on the ventral (belly) surface of the abdomen (Figure 5) which are used to support their egg-masses. Males do not have the pleopods.

Figure 5. Female coconut crabs; encircled the feathery pleopods on the side of the abdomen.

Moult

An indication is obtained of when the crab last moulted. Previously this was done by examining the hairs and dactyls of the walking legs – if hairs are present and the dactyl is sharp the crab has moulted recently, whereas if the hairs are absent and the dactyl blunt it most likely moulted a year ago (Murdoch 2004). As this is a rather subjective measure a less disputable index is now used to obtain moult stage:

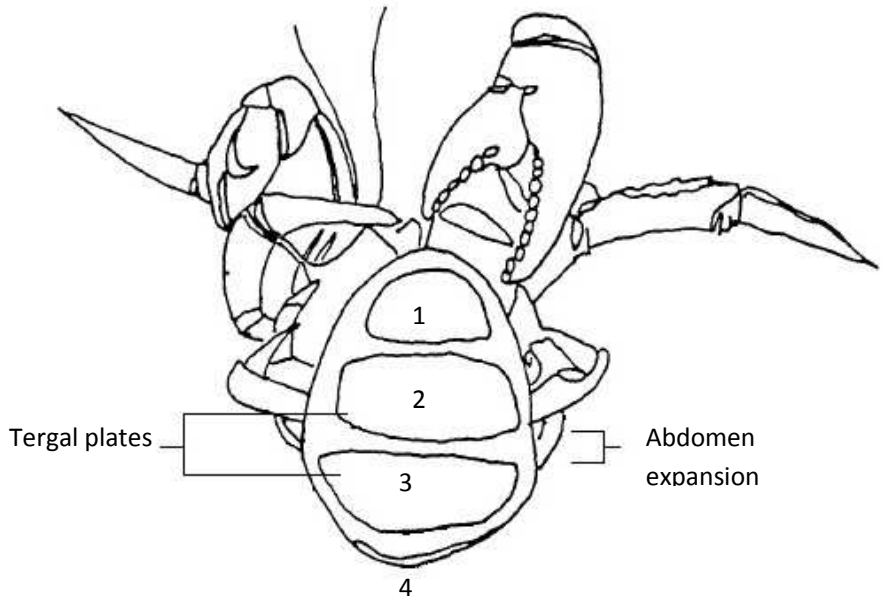

Figure 6. Tergal plates on abdomen coconut crab and moult stages

On the abdomen of coconut crabs there are four tergal plates which are separated from each other (see Figure 6). Before the coconut crab moults, its abdomen becomes greatly enlarged (Fletcher 1990b)due to accumulation of fluid in the abdomen. During this process the tergal plates will gradually be pushed apart by the swollen fleshy part of the abdomen. The moult stage of the individual is derived from an index of abdominal expansion and is divided in four categories; 1, 2 , 3 and 4.

1; All tergal plates are touching each other or there is a small 'gap' between plates 1 and 2.

2; The abdomen is slightly swollen and the fleshy abdomen is visible between plates 1,2 and somewhat between 2 and 3

3; The abdomen is swollen and the fleshy abdomen is clearly present between plates, 1,2,3 and starting between 3 and 4.

4; the abdomen is strongly swollen and all tergal plates are divided by a thick fleshy abdomen.


Moult stage 1, blue morph

Moult stage 2, orange morph


Moult stage 3, orange morph

Moult stage 4*, orange morph

*Picture shows coconut crab that is very close to stage 4. These crabs arealmost never encountered because the coconut crabs will be hiding in their burrows when they reach that stage.

Morph

On Aldabra there are two colour morphs (orange, blue) and an intermediate morph (mix of orange and blue). Colour is most effectively judged on the underside of the front claws. Orange has orange shell and white claws and blue is purple/blue abdomen with blue/white claws.

Data entry and analysis

The data is entered into the appropriate digital Access database by the same staff that conducted the monitoring, and should be done as soon as possible after the survey to avoid mistakes during data transfer (data checking is a further step to ensure accuracy of the data). Data are to be stored on the network and backed up regularly. The data entry files are electronically accessible on the server at:

\\ALDABRASERVER\fileserver\Monitoring\Invertebrates\Coconut Crab\Data\coconutcrab.mde

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