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Some aspects of caudal autotomy of *Podarcis filfolensis* (Bedriaga 1876).

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Abstract.

Caudal autotomy, the ability to shed the tail, is common in a number of lizard species as a response to attempted predation and is a well studied subject. In this short work, attention to the species *Podarcis filfolensis* (Bedriaga 1876) is given based on several years of field observations.

Introduction.

Caudal autotomy, or the voluntary self-amputation of the tail, is an anti-predation strategy in lizards that depends on a complex array of environmental, individual, and species-specific characteristics. These factors affect both when and how often caudal autotomy is employed, as well as its overall rate of success. The potential costs of autotomy must be weighed against the benefits of this strategy. Many species have evolved specialized behavioural and physiological adaptations to minimize or compensate for any negative consequences. One of the most important steps following a successful autotomous escape involves regeneration of the lost body part. In some species, regeneration occurs rapidly; such swift regeneration illustrates the importance of an intact, functional tail in everyday experience. In lizards and other vertebrates, regeneration is a highly ordered process utilizing initial developmental process as well as regeneration-specific mechanisms to produce the correct types and pattern of cells required to sufficiently restore the structure and function of the sacrificed tail. (Clause & Capaldi, 2006). By far the most common and best-studied examples of tail autotomy, however, are among the lizards (Suborder Sauria), where caudal autotomy is a major predator escape tactic in species within 13 of the 20 lizard families (Downes & Shine, 2001). Although caudal autotomy may be natural, it is stressful to the lizard. Not only do they need to spend energy healing the stump and regrowing the tail, but the loss may occur at a critical time, such as during gestation or a period of low food availability.

The Maltese Wall Lizard belongs to the genus *Podarcis* that consists of at least 18 species, within these over 195 listed as subspecies (Grech 1999). *Podarcis filfolensis,* (Bedriaga 1876) is endemic to the Maltese Islands and the Pelagie Islands, Lampione and Linosa (Lanza, 1973). Four subspecies of this lizard have been named from the various islands of the Maltese group and one subspecies from the Pelagian Islands and these were separated only from morphological grounds (Sciberras 2007). Savona-Ventura (1983) also regards the population on the island of Cominotto as a distinct subspecies, which he did not name. 17 geographically isolated populations are known to occur (Sciberras 2010).

The latter species was observed over the years by the present author to be preyed by several species and its first line of defence is accelerated speed which makes it almost impossible to catch. The second most promising line of defence is caudal autotomy. Other tactics far less impressive but occasionally work include sound productions (hissing, puffing of flaks and neck etc), inaccessibility, immobility, body trashing, gaping, biting and cloacal discharge.

Previous works.

Despite the best-studied examples of tail autotomy are the lizards, almost no data was ever published on caudal autotomy of *Podarcis filfolensis*. However a few references were made by Boffa (1966), Lanfranco (1969). The pioneering work carried out on the subject in the unpublished work by Borg (1989). Grech (1999) in his unpublished work carried out also some minor observations.

Use of the tail.

The tail in *Podarcis filfolensis* as well as in other lizards is usually multi functional. In the present species it was noted to be used a part of a communication devise between individuals of the same species both for the same gender and opposite sex. This use showed that it can prevent most physical combat by showing submissive or dominant action as part of other physical movements of the body as well as attracting a mate, other weary signs as to the individual prefer staying alone, and excitement to showing alarming signs as to warn others in the vicinity that danger is close. Although tail lashing is not a functional weapon, it was noted to be also used against rivals and predators as a warning sign. The original tail was noted to be used a third arm in most occasions especially when the lizard is of a particular height moving on a ledge or on a shrub. When resting on high areas they tend to keep the tail loosely coiled to the object they are on. Similar observations were carried out by Borg (1989). Maximum speed is reached by mature lizards when they retain their original tail as is a functional tool in balance when taking a sharp turn during a speedy run usually holding the latter upwards **(Fig 1)**.

Lizards with no tail or regenerated ones lose some of this quick mobility and tend to be more submissive in most occasions. Studies by Brown, R.M. et al.(1995) show otherwise. Other alterations in behaviour and morphology were also noted. Most noted were in an occasional number of adult specimens and the latter tend to become more obese, at the same time as they become more cautious, they tend to be more alert and let the predator/ rival to approach much less shorter distances.

Figure 1.

Cooper Jr. (2007) also notes that captured but non-autotomized lizards also demonstrated longer flight initiation distances, suggesting that the lizards perceive an increased risk of predation. Original tails are also important when emergency swimming needs to take place. Similar behaviour was noted on *Podarcis sicula* by Arnold (1984) and Borg (1989).

Colouration.

Figure 2.

In *P. filfolensis* populations as well as in other *Podarcis* species Ex, *P. wagleriana* data collected by the author between 1997- present show that original tail colouration consists of repetitive pattern on each of the next segment ie: segment pattern 1 is followed by segment pattern 2 and the latter is followed by segment pattern 1 again**. (Fig 2).**

On the other hand regenerated tails are a different matter. After 'injury' which will usually take 6-8 hours to heal **(Fig 3)** (blastema formation)

Figure 3.

and for the new regenerated tail from 2- 3 weeks (over 25 degrees) to bud in warm temperature and from 4-6 weeks in low temperature (less than 25 degrees), the budding part is always entirely black **(Fig 4).**

Regenerated tails growing in cold seasons tend to be black in colour while those growing in warm weather tend to be brownish **(Fig 5)**.

Figure 4.

Hypothetically the colouration of a growing regenerated tail during different temperature seasons maybe argued that lizards need black coloured tails in cold conditions to absorb more heat thus enabling better circulation in the tail and growth. Warmer conditions may not need such dark colours (pers .obs)

Figure 5.

Unlike Grech`s assumption that the tail will stay permanently black several specimens will display an alternative colouration when tail is fully grown. Also when the tail starts taking the final colour, the regenerated tail always consists of repetitive pattern on each segmented scale.

Usually it has the coloured pattern of the final scale prior the autotomy point. In some cases the final scale pattern is enhanced in a brightly colour and this will follow through the rest of the regenerated tail **(Fig 6).**

The latter was observed mostly on specimens of minor islets. Tail colouration may also vary from right to left sides on the same tail after regeneration **(Fig 7).** If the regenerated tail is autotomised again in any section of it, the new part growing on the regenerated tail may poses a different colouration **(Fig 6, 7).** It was also noted that lizards under 2 years of age on the minor islets are the most likely specimens to have coloured tails after autotomy than older specimens.

Figure 6.

The latter were noted to grow a plain brownish non-patterned tail, but this is not always the case as a male specimen of an age scale of 5-7 years grew a fully coloured tail in a period of 3 months. It is possible that bright colours assist sub adult specimens to achieve better dominancy in the lizard population, possibly a factor that reduce physical combats among other displays (per. obs) Juveniles of a variety of lizard species exhibit bright tail colours that contrast clearly to the cryptically coloured body. The "predator escape" hypothesis suggests that bright tail colours deflect the attack of a predator towards the lizard's tail, which can be autotomised, and hence increase the probability of surviving a predatory attack. Although this hypothesis is widely accepted, surprisingly few empirical data exist to support it. (Aurora ,M eta .al.1999) The "aposematic (unprofitable) prey" hypothesis states that brightly coloured prey signal their unpalatability and thereby reduce the incidence of predatory attacks (Arnold, 1984; Cooper and Vitt, 1985).

Figure 7.

Finally, the "conspecific signalling "hypothesis proposes that right tails signal the juvenile status and hence decrease conspecific aggression, or even cannibalistic attacks (Arnold, 1984; Clark and Hall, 1970; Arnold, 1984; Cooper and Vitt,1985).

Identification of regenerated tails.

For the reasons mentioned above the only way of identification of regenerated tails in the field is clearly as discussed by Borg (1989) i.e. the identification point of caudal autotomy. These sections were autotomy took place generally represent longer scales to the one previous to it. Thicker, stubbier tails and the lack of different markings usually give the tail away but on exceptional occasions, specimens were found with the latter morphological features and retained an original tail. In laboratory conditions one can always be ascertain by radiography as regenerated tails never grow another vertebrae but always have the latter replaced by a cartilaginous tube (Arnold,1988).

General morphology of the tail.

From a study of over 700 specimens of *P. filfolensis* from several populations, the original tails were observed to have an average segment count of 87-104 segments from the pygal vertebrae to the tip. Regenerated tails are extremely variable (depending mostly from the point of autotomy) but usually do not have more than 60-80 segments. Thickness of the tail may vary, usually becoming thicker than the original tail and may start to be used especially in older specimens as a fat reserve. In most cases the regenerated tail will not grow as long as the original tail but this depends mostly from where the location the tail has been amputated, the age and environmental conditions of the microhabitat the specimen is living in.

Averages of 275 specimens of lizards were studied in several conditions ranging from minor islets harsh conditions to lush gardens on the mainland island of Malta. The majority of the original tails are lost within the first 2 years of the specimen's life (pers .obs)

Reasons for tail autotomy.

The most common and obvious reason of caudal autotomy in this species is predation. Few naturalists including Boffa (1966) mention that tail loss was conducted during combats within the same species. In all the years of field observation, only in one case was the tail lost during a fierce combat which lasted over 3 minutes (normal physical combats always last less than 30 max 78 seconds) and the opponent was exceptionally large when compared to its losing rival. The tail was later consumed by the winning specimen so a form of predation was also involved. In most cases, even if the opponent is a predator the tail is lost as a last resort. When threatened *P. filfolensis* tends always to find an escaping route first, then immobilise itself, keeping safe distance from the opponent and wriggle its tail in a seducing mode to see if the latter has any interest. If the predator is fast, it is more likely that the lizard will self amputates the tail rather than being caught first by the tail or other area and tail breakage occurs later. If the opponent is manageable and can be dealt with, or if the lizard is cornered it may after several warning signs attack the opponent. Lizards that are already caught rarely lose theirs in anxiety or unless they found a means of escape, but continue to trash their body until the eventual release. Lizards with regenerated tails tend to be more cautious and flee from site more quickly and also the regenerated tail is far less mobile and of less use during attack. It was also noted that lizards with regenerated tail perform far less self amputations and if it occurs it usually occurs from the same scale segment of the original caudal autotomy. (pers .obs)

Caudal autotomy rates.

Caudal autotomy rates are very different between populations of *Podarcis filfolensis.* There is also a significant difference between sexes. In most populations 80 % of the females retain their original tail while less than 50 % of the males have their original tails. Areas were predation is high, for example on the island of Filfla or in some localities on the island of Malta Ex: Msida and Baħar iċ- Ċaghaq, caudal autotomy is very evident and specimens are more readily to give up their tails in case of attack. Lizards on isolated islets often offer a very different perspective. Most of their tails are original as it was noted that during combats especially between males, it was more likely to lose a digit rather than the tail.

Figure 8.

Since most populations are almost unaware of any means of predation except the occasional sparrow (*Passer hispaniolensis*), which a common species and the commonest predator on lizards caudal autotomy, it is usually not a common choice. (Fornasari, L. & Zava, B. 2000 & Sciberras unpublished data) In a collecting trip held in 2003 for a genetic study, several lizards caught did not show any signs of caudal autotomy even when they were held only from the tip of their tail **(Fig 8)** and also given the opportunity to escape but held from their tail. From 5 islets,85 % were not capable to perform caudal autotomy. This was particularly evident on the Islet of Large Blue Lagoon Rock.

Regeneration rate.

Different species have different caudal regeneration rates as clearly displayed by Bellairs and Bryant (1985). Borg (1989) also calculated from specimens of *P.filfolensis* studied in captivity that specimens that regenerated their tails in summer grew 5 times as faster than those growing in spring.

The present author noted also that each isolated population of *P.filfolensis* have different regeneration rates and this is usually constant to the size of the specimen. It also varies within individuals of the same population. As a general rule, the larger the specimen, the slower the regeneration is, same goes with age, i.e.: the older the specimen the slower the regeneration is. Also the location of caudal autotomy also plays a significant role. The less scale segments are lost the faster the regeneration is. It was also noted that females have a faster regeneration rate than males but this maybe also attributed to size as females are generally smaller than full adult males.

From a study of 28 individuals, it was noted that second or more regeneration of the tail on the same specimen results in faster growth.

This is observed when also comparing with the first regeneration in the same temperature and microhabitat conditions. The rate in most populations and individuals is by almost 23% faster.

All of this work is however incomplete as not all 17 isolated populations known were studied in depth the same amount of hours and number of specimens. For this reason average numbers of growth rate are not given in the present study as they are still underway.

Cannibalism.

Cannibalism was noted in several occasions especially among isolated populations in harsh conditions. Regarding the tail, it was noted that among juveniles being cannibalized and eaten hole including the tail, lost tails not devoured by the predator or other opportunistic feeders were either eaten by other lizards or later collected by their owners and eaten by themselves. The tail is taken usually when it is still wriggling but it was also observed being later taken by its owner even after it stopped wriggling.

Amputated tail motion.

Wriggling generally takes place right after amputation and motion is more vibrant and fast during the first 30 second until it almost stops completely after 4 minutes (Borg, 1989 ,Sciberras unpublished data). Self amputated tails have a tendency to wriggle more violently and for a longer period (longest calculated was 5 min 12 seconds) rather than those that were amputated by the attacker (pers. obs).

Popular belief.

Lanfranco (1965,1969), Savona – Ventura (1983), Schembri(1986) and Sciberras (2006) describe how it is popular belief that all lizards of Filfla are two tailed. Obviously this is a phenomenon that occurs in all populations of the Maltese lizard however there is a possible scientific fact while occurrences of bifid tails in this population are more common. Another popularly folkloristic belief is when a human amputates a lizards' tail, the latter wriggles to offend the attacker. Folkloristic beliefs are still unfortunately an important tool in conservation among locals of this and other species (Sciberras 2009).This species was intensively studied folkloristically in Sciberras 2006, 2007.

Conclusion.

It is evident from this study that much more research has to be carried out before a clear picture of all caudal autotomy in *P. filfolensis* can be put in place. Although this subject was studied intensively in other species, in this work it shows that even one species has a lot of variability in results, mostly depending on the microhabitat they are situated in. Many of these populations have adapted to a hard arid life and some on the main islands have became accustomed and well adapted to human intervention. Thus, small isolated populations are of a different concern and may be easily wiped out buy any human mishap (Sciberras and Sciberras, 2014). One population which existed on the island of Selmunett is already wiped out by human intervention, the likely cause being the introduction of the alien species *Rattus norvegicus*(Sciberras 2005, Sciberras and Schembri, 2008., Sciberras 2010) and the population of Fungus Rock may ultimately one day face the same fate.(Sciberras,2007)

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REFERENCES.

Arnold. E.N. (1984). Evolutionary aspects of tail shedding in lizards and their relatives. J. Nat. History 18, 127–169.

Arnold. E.N. (1988). Caudal autotomy as a defence. In Biology of the reptilia. Gans, C. & Huey, R. (Eds). New York: Alan R. Liss, p. 235–273.

Aurora. M,C., Gosa. A., Galan. P & Perez – Mellado.V(1999). GREEN Tails in LIZARDS OF THE GENUS *PODARCIS:* DO THEY INFLUENCE THE INTENSITY in PREDATION? Herpetologica 54(4) 530-537).

Boffa. C.J. (1966). The islets of Comino and Filfla. Lux Press-Malta

Borg. M.J. (1989). Aspects of the biology of *Podarcis filfolensis*. Unpublished B.Ed. dissertation, Faculty of Education, University of Malta, Malta; viii + 130pp.

Bellairs. A.D.A. & Bryant. S.V. (1985). Autotomy and regeneration in reptiles. In Biology of the reptilia: 301. Gans, C. & Billet, F. (Eds). New York: Alan R. Liss, p. 301–410.

Brown. R.M., Douglas. T.R., & Gist. D.H.(1995). Effect of Caudal Autotomy on Locomotor Performance of Wall Lizards (Podarcis muralis)*Journal of Herpetology* Vol. 29, No. 1 pp. 98-105.

Clark. D. R., & Hall. R.J (1970). Function of the blue tail-coloration of the five-lined skink (Eumeces *faciatus)***.** Herpetologica 16:271-274.

Clause. R. & Capaldi. A.E.(2006). Caudal autotomy and regeneration in lizards. Journal of Experimental Zoology Part A: Comparative Experimental Biology Volume 305A, Issue 12

Cooper. W.E. Jr, & Vitt. L.J. (1985). tails and autotomy: enhancement of predation avoidance in juvenile skinks. Zeitschrift f3r lierpaychologie 70;265-276.

Cooper. W.E.Jr. (2007). Compensatory changes in escape and refuge use following autotomy in the lizard *Sceloporus virgatus*. Can. J. Zool. 85, 99–107.

Downes. S.J. & Shine, R. (2001). Why does tail loss increase a lizard's later vulnerability to snake predators? Ecology 82, 1293–1303.

Fornasari. L. & Zava, B. (2000). Predazione di *Podarcis filfolensis laurentiimuelleri* da parte di *Passer hispaniolensis maltae* sull'Isola di Linosa. In: *Societas Herpetologica Italica, 3° Congresso Nazionale.*

Grech. R.(1999). Aspects of the behavior of the Maltese wall Lizard(Podarcis filfolensis)in coastal areas. Faculty of Education, University of Malta, Malta.

Lanfranco. G.G. (1965). The tail of a tail.. Times of Malta Oct 21st .

Lanfranco. G.G. (1969). A two tailed Lizard from Sliema. News and views pg 740.

Lanza. B. (1973). Gli anfibi e i rettili delle isole circumsiciliane. *Lavori della Società Italiana di Biogeografia (Nuova Serie)* 3, 755-804.

Savona Ventura. C. (1974). The Lacertila of the Maltese Islands. *The Maltese Naturalist* 1(6):26-29.

Savona Ventura. C. (1983). The herpetofauna of Comino and satellite islets with a note on the colouration of *Podarcis filfolensis*. *Animalia* [Catania, Sicily] 10, 87-93.

Savona Ventura. C. (1983). Fauna of the Maltese Islands: Maltese Wall Lizards. Heritage; 51:1006-1007 .

Schembri. P.J (1986). The Maltese Wall Lizard. Civilization 27:741-743.

Sciberras. A. (2005). Observation on the endangered population of the Maltese wall lizard of Selmunett island (*Podarcis filfolensis kieselbachi*).Unpublished work, presented to the chamber of young scientists of Malta at 4- 10th April ,winning the contest 1st place and leading to the Belgian Science expo on 26 April to 1May

Sciberras. A. (2006). Ghajdut, Qlajjiet u Folklor fuq il-Gremxula ta' Malta.L-Imnara Vol 1pt 8 no 30 pg108-112.{in Maltese}

Sciberras. A. (2007). Lizards At Id-Dwejra. Dwejra Heritage Park Gozo pgs.28-33. Dwejra Management Board.
Sciberras. A. (2007). Ghajdut, Qlajjiet u Folklor fuq il- Rettili u Amfibji ta' Malta.L-Imnara Vol 1pt 9 no 31 pgs.200-208. {in Maltese}
Sciberras. A. & Lalov. S,V. (2007). Notes On The Impact Of The Black Rat(Rattus rattus L.) On The Flora And Fauna Of Fungus Rock (Maltese Islands). The Central Mediterranean Naturalist Vol 4 (3) pgs.207-210. Nature Trust Malta publications.
Sciberras. A. (2007). The presence of *Chamaleo chamaleon (*Reptilia) on the Maltese islands with a note on the occurrence of this species on Cominotto Island and its possible effects on the endemic local lizard. Herpetological Bulletin-Number 102 pgs 38-40.
Sciberras. A. & Schembri. P.J. (2008). Conservation Status of St Paul`s Island Wall Lizard (*Podarcis filfolensis kieselbachi).*Herpetological Bulletin-Number 105 pgs.28-34.
Sciberras, A. (2009) Need for a herpetological society in Malta. The Times, October 9th pg.10.
Sciberras. A. (2010). Reptiles at Hagar qim. The Sunday Times, July 25th pg.19.
Sciberras. J. & Sciberras. A. (2014). Behavior of lizards in the Maltese and Pelagian islands: a personal experience. L@CERTIDAE (Eidechsen Online), 2014 [1]: 1-10.

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