Substrate-dependent colour variation along the Kāpiti–Taranaki coastline and biological notes on *Actizeta albata* (Coleoptera: Tenebrionidae)

Shaun Thompson

(E-mail: shaun.thompson301@gmail.com). Orcid: 0000-0001-9988-5985

This study investigated whether colouration of the beetle *Actizeta albata* Pascoe, 1875 matches the sand substrate along the Kāpiti–Taranaki coastline of the North Island. In *A. albata*, colouration may vary from mostly white to mostly black. Specimens were collected from the black sand beaches of the Taranaki–Whanganui region and grey sand beaches of the Kāpiti region. The extent of dark patterning on each specimen was traced and then quantified in ImageJ. With this data, specimens from black sand beaches were found to be significantly darker than those from grey sand beaches using a Mann-Whitney-Wilcoxon test ($p < 0.01$). Although this pattern is consistent with cryptic colouration, another possibility is that the darker colouration is the result of differences in sand grain abrasiveness causing scales to be eroded more quickly, making the beetles appear darker in colour. Additionally, general biological observations of the genus *Actizeta* from fieldwork and keeping the beetles in captivity are also recorded.

Introduction

Within species, colouration can serve various functions and often varies substantially between populations. Some species may exhibit cryptic colouration where the colouration of the body may closely match the surrounding environment. This has been observed in species that live in sandy environments such as the New Zealand seaweed beetle *Chaerodes trachyscelides* White 1846, which can vary substantially in colour and tends to match the sand substrate they reside on (Harris 1988). This has also been observed in several dune-dwelling species of the tiger beetle *Zecicindela* (Larochelle & Larivière 2013). Similar substrate-dependent

variation may occur in other sand-dwelling beetles but is poorly documented in New Zealand.

The genus *Actizeta* is composed of two species: *Actizeta albata* Pascoe, 1875 and *Actizeta fusca* Watt, 1992. Both species live along the coastline on sandy beaches and in sand dunes, with *A. albata* being recorded from the North Island and northern half of the South Island whereas *A. fusca* is only known from the North Island (Watt 1992b). Although they are relatively abundant, due to their small size and burrowing habits they are seldom observed. When the sand is warm enough, the beetles climb to the surface of the sand and can be seen roaming in search of food. As adults, they act as scavengers and will feed on various food sources such as dead invertebrates and fish (Harris 1970a). The body of the beetle is covered in distinctive white and black patterning, particularly on the elytra and pronotum, that can vary substantially within and between populations (Fig 1).

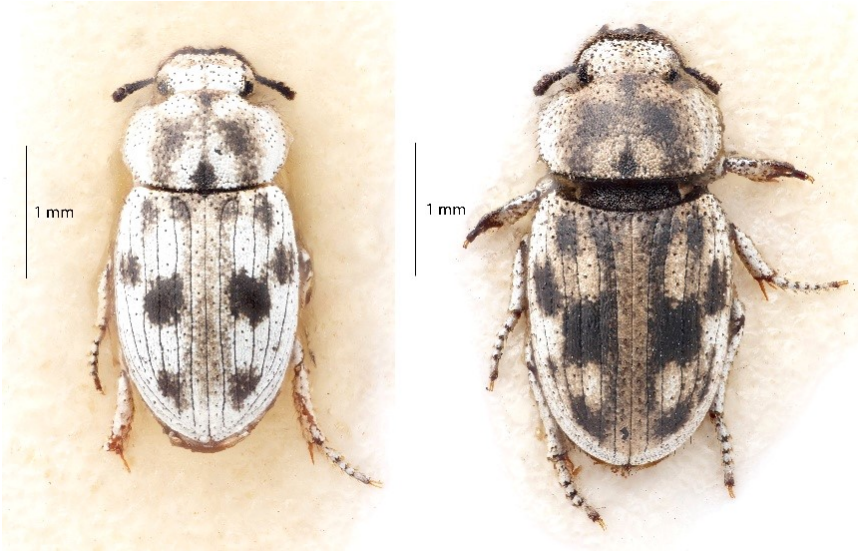

Figure 1. *Actizeta albata* collected from Waikawa beach (left) and from Patea beach (right). Photos by Bryce McQuillan. All rights reserved.

The sand along the coastline of the Taranaki and Whanganui regions is derived from volcanic andesite rocks which are prevalent in the region. These rocks are rich in titanomagnetite and other darkly coloured minerals which give the sandy beaches in the region a distinctive black colour (Brathwaite et al. 2017). To the south of these regions the source material for the sand changes to sedimentary greywacke, which causes the sand to gradually shift to a light grey colour in the Kāpiti region (Kasper-Zubillaga et al. 2006). While travelling in these regions, the author searched for *A. albata*, particularly in the Taranaki region where few specimens have been observed. During this time, it was noted that populations of *A. albata* in the black sand regions appeared to be coloured darker than those from grey sand regions (Fig 1), but the differences were subtle enough that more extensive sampling would be needed to confirm this.

To investigate this observation, this study aims to determine if there is variation in the colouration of *A. albata* along the Kāpiti–Taranaki coastline. Based on previous field observations, it was hypothesised that *A. albata* from the black sands of the Whanganui–Taranaki region would have darker colouration than those from the grey sands of the Kāpiti region. Observations on the general biology of the genus *Actizeta* from fieldwork and keeping specimens in captivity are also recorded.

Method

Collection

The beetles were collected from several beaches along the Kāpiti–Taranaki coastline throughout January and early February 2026 (Fig 2). This stretch of coastline was selected as the overall sand colour is light grey in the Kāpiti region before transitioning to black coloured in the Whanganui–Taranaki region. In the Kāpiti grey sand region, Waikanae, Waikawa and Foxton beaches were selected whilst in the Whanganui–Taranaki region the Patea and Ohawe beaches were chosen. Kai Iwi and Kaupokonui beaches were also considered, but the beetles were either absent or too few.

From each beach, a minimum of twenty live *A. albata* specimens were collected. The beetles were primarily collected by sieving sand with a stainless-steel sieve that had a mesh size of 3 x 3 mm. Loose dry sand from

the base of dunes was passed through the sieve and the remaining debris were placed into a tray and searched through for the beetles. The sand was then returned to the dune to prevent erosion. Alternatively, the beetles were sometimes found walking on the surface of sand or feeding on dead carrion. After collection, the beetles were card mounted.

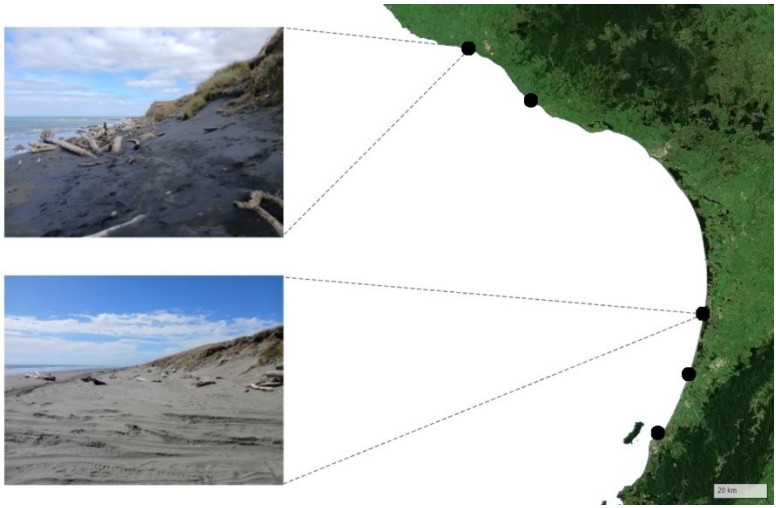

Figure 2. Map of collection sites (black dots) on the Kāpiti–Taranaki coastline with images of Ohawe beach (top) and Foxton beach (bottom) to demonstrate differences in sand colour between regions.

Body colour

The elytra and pronotum are covered in scales that range from white to light brown in colour while the base colour of both features are black. Some scales may be wholly or partly transparent, which exposes the black colour of these segments and thus creates black patterning which makes the beetle appear overall darker in colour. Alternatively, scales may also be missing, which also causes black colouration. To determine the extent of black patterning, the beetles were examined under microscope, and the extent of black areas was digitally traced in Photopea (2026) onto an

outline template of the elytra and pronotum and coloured black. This image was then imported into ImageJ (Schneider et al. 2012). The histogram function was used to count the number of black pixels. The proportion of black pixels relative to other pixels was then used to determine the percentage of the elytra and pronotum that were coloured black.

Table 1. Location of collection sites with their sand colour type and specimens collected.

Beach	Sand colour	Number of specimens
Waikanae	Grey	22
Waikawa	Grey	22
Foxton	Grey	31
Patea	Black	21
Ohawe	Black	29

Statistical tests

All statistical tests were performed in RStudio (Posit team 2026) and the dataset was broken down into the two beach sand colour categories: grey and black. The normality of the data was tested using the Shapiro-Wilk test and was found to be non-normally distributed. The two sand colour categories were tested for significant differences between groups using a Mann-Whitney-Wilcoxon test. The data from all five beaches were used to create box and whisker plots to visualise the dataset.

Results

A total of 125 specimens were collected: 75 from grey sand beaches and 50 from black sand beaches (Table 1). The box and whisker plots (Fig 3)

show that the beetles collected from the black sand beaches were generally darker in overall colour than those from the grey sand beaches. This is further confirmed by the Mann-Whitney-Wilcoxon test, which found there was a significant difference between the two groups ($p < 0.01$).

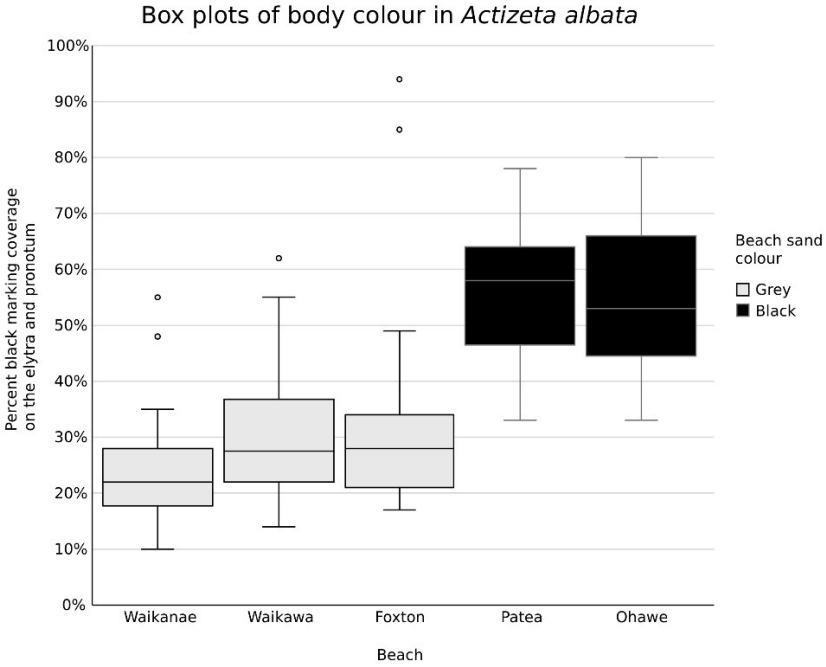

Figure 3. Box-and-whisker plots showing the percentage of black markings covering the elytra and pronotum. Plots are presented for each collection site, with beach sand colour indicated.

Discussion

Specimens from the black sand beaches in the Taranaki–Whanganui region were distinctly darker than those from the grey sand beaches of the Kāpiti region, confirming the hypothesis. However, this finding is limited to the

Kāpiti–Taranaki coastline and further investigation is needed to confirm that this pattern is consistent throughout New Zealand's beaches.

The darker colour of *A. albata* on the black sand beaches could be interpreted as an example of cryptic colouration, where a species is coloured to blend in with its surrounding habitat. Individual *A. albata* with colouration that more closely matches their substrate may blend in better and be more able to avoid being predated on. This pattern is consistent with some other coastal beetles, such as *C. trachyscelides* and *Zecicindela*, where colouration matches the sand substrate (Harris 1988; Larochelle & Larivière 2013).

Although cryptic colouration is a tempting explanation, another possibility is that the different sand types wear away the body scales at different rates. Under microscope, sand grains from the two black sand sites were larger and more angular than those from the grey sand sites. It is possible that because of this, the black sand causes the scales to erode more quickly, thus making the dark markings more extensive. As such, the darker colouration of *A. albata* on the black sand beaches may instead be coincidental. To test this, further studies could compare colouration of *A. albata* between beaches with similar colours, but differing grain sizes and shapes.

In conclusion, along the Kāpiti–Taranaki coastline *A. albata* from black sand beaches were consistently darker than those collected from grey sand beaches. Although on a surface level this may appear to be cryptic colouration, it is also possible that sand abrasion is the actual cause of this pattern. Further research is needed to examine these two explanations for the substrate-dependent colour variation in *A. albata* along the Kāpiti–Taranaki coastline.

Biological notes

Diet

During fieldwork, *A. albata* was often observed feeding upon dead invertebrates, particularly beetles and sandhoppers, with larger invertebrates having numerous *A. albata* swarming their dead bodies. In captivity, they were successfully sustained for several weeks on freshly killed terrestrial amphipods and would also accept dead flies (both adults and larvae). They were also frequently found feeding on dead seabirds,

sometimes occurring in large numbers. These observations conform with Harris (1970a), who also observed that they frequently fed upon a wide range of dead invertebrates and fish.

It was reported by Watt (1992a) that the gut content of *Actizeta* appeared to be mostly dead plant material. Feeding on dead plant debris was never observed during this study and attempts to feed them carrot in captivity appeared to be rejected, so more study is required to determine if plants constitute part of the adult diet.

Activity

Actizeta has previously been reported to be diurnal by Harris (1970b). However, field observations found numerous instances of *Actizeta* on the surface feeding on carrion at all hours of night. They were also frequently spotted resting above the surface and sometimes seen walking around at night. This was also observed in captive *A. albata* when a camera was set up to image their enclosure every fifteen minutes at night. This appears to be contrary to another experiment by Harris (1970b), where the beetles would burrow whenever the sky became cloudy and the temperature dropped. This behaviour was observed to be true during daytime, but the beetles' nocturnal activities appear to indicate that this behaviour has another layer of complexity to it.

Distribution

Watt (1992b) reported that *A. albata* is widely distributed throughout the North Island and northern South Island as far down as the mid-Canterbury region. Several records on the website iNaturalist have extended this range to Dunedin. Due to the cryptic nature of the species, it remains possible that its distribution extends even further south.

***Actizeta fusca* habitat**

On some beaches, particularly Waikawa and Foxton beach, *A. fusca* was frequently found co-occurring with *A. albata*, albeit in smaller numbers. Watt (1992a) reported that this species tends to occur further inland than *A. albata*. Field observations during this study noted that while both species can be found throughout dune systems, *A. fusca* did not appear to be more abundant further inland. This should be further investigated with a population distribution survey.

Acknowledgements

The author wishes to thank Bryce McQuillan for providing excellent photos of *Actizeta albata* and for initial instruction on how to find the beetle.

References

Brathwaite RL, Gazley MF & Christie AB. 2017. Provenance of titanomagnetite in ironsands on the west coast of the North Island, New Zealand. *Journal of Geochemical Exploration, 178*: 23–34. https://doi.org/10.1016/j.gexplo.2017.03.013

Harris AC. 1970a. Coastal beetles of the Wanganui-Manawatu area part 1. Environmental factors and zonation". *Bulletin of Natural Sciences. Wellington. 1*: 45–58.

Harris AC. 1970b. Coastal beetles of the Wanganui-Manawatu area part 2. Morphological, physiological and behavioural adaptations of psammophilous burrowing beetles. Appendix: experiments on physiological tolerances". *Bulletin of Natural Sciences. Wellington. 1*: 59–87.

Harris AC. 1988. Cryptic colouration and melanism in the sandburrowing beetle Chaerodes trachyscelides (Coleoptera: Tenebrionidae). *Journal of the Royal Society of New Zealand, 18*(3): 333–339. http://dx.doi.org/10.1080/03036758.1988.10426474

Kasper-Zubillaga JJ, Ortiz-Zamora G, Dickinson WW, Urrutia-Fucugauchi J & Soler-Arechalde AM. 2006. Textural and compositional controls on modern beach and dune sands, New Zealand. *Earth Surface Processes and Landforms, 32*(3): 366–389. https://doi.org/10.1002/esp.1403

Larochelle A & Larivière M-C. 2013. Carabidae (Insecta: Coleoptera): synopsis of species, Cicindelinae to Trechinae (in part). *Fauna of New Zealand, 69*: 1–193 https://doi.org/10.7931/J2/FNZ.69

Photopea. 2026. [Online image editor]. https://www.photopea.com

Posit team 2025. *RStudio: Integrated Development Environment for R*. Posit Software, PBC, Boston, MA. http://www.posit.co

Schneider CA, Rasband WS & Eliceiri KW. 2012) NIH Image to ImageJ: 25 years of image analysis. *Nature methods 9*(7): 671–675. https://doi.org/10.1038/nmeth.2089

Watt JC. 1992a. Relationships of Actizeta and Cnemeplatiini (Coleoptera: Tenebrionidae). *Systematic Entomology, 17*(3): 287–299. https://doi.org/10.1111/j.1365-3113.1992.tb00339.x

Watt JC. 1992b. Tenebrionidae (Insecta: Coleoptera): catalogue of types and keys to taxa. Fauna of New Zealand, 26: 1–72. https://doi.org/10.7931/J2/FNZ.26