***Original Research Article***

**Comparative efficacy of selected chemicals and bio-pesticides against shoot and fruit borer, *Leucinodesorbonalis* (Guenee) on brinjal, *Solanummelongena*(L.)**

**ABSTRACT**

The present investigation was conducted at the research plot of the Department of Entomology at Central Research Farm (CRF), Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, during the *Kharif* season of 2024. The experiment was laid out in randomized block design (RBD) with three replications and eight treatments were evaluated against brinjal shoot and fruit borer (*Leucinodesorbonalis,* Guenee). The cumulative mean of the spray were observed that, the data on the per cent infestation of shoot and fruit borer on the 3, 7 and 14 day after spray revealed that all the chemicals treatment were significantly superior over control. Among all the treatments lowest percent shoot infestation was recorded in Chlorantraniliprole followed by Emamectin benzoate *Emamectin benzoate* 5% SG and Spinosad45% SC. Treatment Cypermethrin25% EC, *Beauveria bassiana* were statistically at par with each other and treatments NSKE 5%, Neem oil 2% were found be least effective but significantly superior over the control.The highest Benefit cost ratio was recorded Chlorantraniliprole (1:8.89) followed by Emamectin benzoate *Emamectin benzoate* 5% SG (1:7.81) and Spinosad45% SC (1:7.80). Treatment Cypermethrin25% EC (1:6.49), *Beauveria bassiana* (1:5.89) were statistically at par with each other and treatments NSKE 5% (1:4.89), Neem oil 2% (1:4.45) as compared to control(1:3.86).

**Keywords:** Brinjal crop, *Leucinodesorbonalis*, chemical control, cypermethrin 25% EC, neem oil, chlorantraniprole

1. **INTRODUCTION**

Brinjal, also known as eggplant or Aubergine (*Solanum melongena* Linnaeus), belongs to the Solanaceae family. It is a native of Indo-Burma region, and was known to be grown in India since ancient times. Amongst the solanaceous vegetables, brinjal is one of the most common, popular, principle annual crop grown in all the three seasons and economically important vegetable among small-scale farmers as it is a source of cash income for resource poor farmers. The major brinjal growing states in India are, Andhra Pradesh, Karnataka, West Bengal, Tamil Nadu, Maharashtra, Orissa, Uttar Pradesh, Bihar and Rajasthan. In India, West Bengal contribute highest area 181.5 million hectare and production 2877 milliontones, Karnataka has highest productivity 25.4 million tonnes per hectare. In Uttar Pradesh, the area under cultivation of brinjal is 3430 hectare producing 111.70 MT and the productivity is 8 MT/ha **(Sanjana *et al.,* 2019**).

Brinjal (*Solanum melongena* L.) belongs to the family Solanaceae and genus Solanum.it bears a fruit commonly used as a vegetable which is available throughout the year Brinjal is an erect annual plant often spiny with large coarsely lobed fuzzy leaves 10-20 cm long and 5-10 cm broad. The plants usually grow 45 to 60 cm high and bears long to oval shaped, purple or greenish fruits. Flowers are white to purple with five-lobed corolla and yellow stamens. The fruit is a fleshy berry containing numerous small, soft seeds Brinjal crop is subjected to attack by number of insect pests right from nursery stage till harvesting. it is reported to be attacked by about 140 species of insect pests of which the shoot and fruit borer (*Leucinodesorbonalis* Guen.) is the most important one. This crop is also attacked by several insect pests like leaf hopper (*Amrascabiguttulabiguttula*), white fly (*Bemisiatabaci*),Aphid (*Aphis gossypii*) and brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee). Brinjal shoot and fruit borer is regarded as one of the most destructivepestattacking brinjal crop right from nursery stage to harvesting. The pest a serious problem because of its high reproductive potential rapid turnover of generations and intensive cultivation of brinjal, both in wet and dry seasons of the year. The yield loss caused by this pest has been estimated up to 70-92 per cent (**Chakraborti and Sarkar**, **2011**). Larvae of pest borer into tender shoots making zigzag feeding tunnels in fruits. It is the most important insect pest of brinjal in Asia, especially in India, Pakistan, Sri Lanka, Nepal, Bangladesh, Africa and South-East Asia, in India this pest is reported to cause 3.3-68.9% damage to fruit and 47.6-85.8% damage to fruits in Orissa.(**Thakur *et al.,*2017)**

Brinjal, is one of the most important vegetables in South and South-East Asia (Thapa, 2010) where hot and wet climates prevail **(Hanson *etal*., 2006).** It belongs to the plant family Solanaceae and is the most commonly grown vegetable of this family. The Indo-Pak Subcontinent is reported to be the native land of brinjal **(Dunlop, 2006).** Its worldwide cultivation is more than 1,600,000 ha and production is 50 million Mt (FAO, 2012). In Pakistan it is cultivated in 9,000 ha and production is 87,000 tons per annum (FAO 2014),(**Aslam *et al.,* 2015).**

Annual production of eggplants in China is first ranked the country accounts for 64.41% of total world eggplant production, cultivated over 781,695 hectares, producing 454,852 hg/ha. Followed by India which accounts for 22.97% of total world eggplant production cultivated over 727,000 hectares with a yield of 174,415 hg/ha and Egypt which accounts for 2.14% of total world eggplant production, cultivated over 43,818 hectares with a yield of 269,350 hg/ha.

Brinjal shoot and fruit borer, BFSB, (*Leucinodesorbonalis*Guenee), (Lepidoptera Pyralidae) is the most serious chewing pest of brinjal crop and it damages the fruits up to 50- 70%. It damages shoot and fruit of brinjal plant in almost all stages of growth. Serious damage is caused by the larval stage of this pest. It is an internal borer which damages the tender shoots and fruits. Adult moth having dirty whitish wings and speckled markings lays eggs on young leaves/ flowers/ calyx of the fruits. After hatching the larvae starts boring into the petiole/ midrib of the leaves/ growing shoots/ flower buds/ fruits and closes the bore hole with frays. Growth, yield and fruit quality of crop and thus make it unfit for feeding purpose (**Kolhe *et al.,* 2017)**.

2. **MATERIALS AND METHODS**

The experiment was conducted during *Kharif*season 2024 at Central research farm, Naini,Prayagraj, Uttar Pradesh, India, in a randomized block design with eight treatments replicatedthree times using variety **Banaras Purple Round**seeds in a plot size of 3m × 2m at a spacing of 60cm × 45cm with a recommended package of practices excluding plant protection.In the experiment, eight different treatments used*viz*. (T1) Cypermethrin25% EC, (T2) Neem oil 2%, (T3) Spinosad45% SC, (T4) NSKE 5%, (T5) *Beauveriabassiana*, (T6) *Emamectinbenzoate* 5% SG, (T7) Chlorantraniliprole, (T0) Control were tested to compare the efficac**y** against shoot and fruit borer (*Leucinodesorbonalis*Guenee) their influences on yield of brinjal.The spraying was done after the population reaching its economic threshold level i.e. the incidence of the borer on the shoot and fruit were recorded from the five randomly selected plants. Observations were recorded one day before spray, 3, 7 and 14 days after spraying. The assessment of the shoot damage was done by calculating the number of damaged shoots and total number of the healthy shoots observed from five randomly selected plants per plot and expressed in percentage. Brinjal fruits were harvested at weekly intervals. The percent fruit damage was total number of affected fruits from each plot. The total yield of the marketable fruits obtained from different treatments was calculated and converted by considering the additional cost (cost of insecticides and operational charges) and benefit (compared to untreated control) in the respective treatments. The percentage of the shoot and fruit infestation was calculated according to the following equations respectively:

No. of shoot infested

% Shoot infestation = ---------------------------------------------- x 100 **(Yadav *et al*., 2015)**

Total no. of shoot

No. of fruit infested

%Fruit infestation = ----------------------------------------- x 100 **(Yadav *et al*., 2015)**

(Number Basis) Total no. of fruit

**Cost benefit ratio:**

Total income was calculated by multiplying the yield per hectare by the current market price. The net benefit was then determined by deducting the total plant protection costs from the total income. To find the benefit over the control, the income from the control treatment was subtracted from the income of each treated plot. The B: C ratio was calculated by following formula:

|  |
| --- |
| Gross return = Marketable yield × Market price |

|  |
| --- |
| Net return = Gross return – Total cost |

|  |
| --- |
| Benefit: Cost Ratio = |

**(Naik and Kumar 2023)**

1. **RESULT AND DISCUSSION**

The data on the percent infestation of shoot borer on brinjal on third, seventh and fourteenthday after spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest percent shoot infestation was recorded in Chlorantraniliprole (3.64) followed by *Emamectinbenzoate* 5% SG (3.95) and Spinosad45% SC (4.34). Treatment Cypermethrin25% EC (4.62), *Beauveriabassiana* (5.14) were statistically at par with each other and treatments NSKE 5% (5.62), Neem oil 2% (5.99) were found be least effective but significantly superior over the control.

The data on the percent infestation of shoot borer on brinjal on third, seventh and fourteenth day after spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest percent shoot infestation was recorded in Chlorantraniliprole (3.91) followed by *Emamectinbenzoate*5% SG (4.35) and Spinosad45% SC (4.61). Treatment Cypermethrin25% EC (5.13), *Beauveriabassiana* (5.31) were statistically at par with each other and treatments NSKE 5% (5.57), Neem oil 2% (5.99) were found be least effective but significantly superior over the control.

These results are in support with **Bhagwan *et al.,* (2017), Kumar *et al.,* (2017), Tripura *etal*., (2017), Palika *et al.,* (2019), Reddy *et al.,* (2022)** who reported that Chlorantraniliprole was found to be superior in reducing the population of shoot an fruit borer.**Bhagwan *et al.,* (2017), Verma *et al.,* (2023), Lekha *et al.,* (2018)** found that *Emamectinbenzoate* was best controlling shoot and fruit borer. **Devi *et al.,* (2015), Marmat *et al.,*(2017), Nail and Kumar (2023)** found that Spinosad was best in controlling shoot and fruit borer. **Yadav *et al.,* (2015), Dongarajal*et al.,*(2017), Thakur *et al.,* (2017), Sahu*et al.,*(2017)** found the Cypermethrin was best in controlling population of shoot and fruit borer. *Beauveria bassiana* is found to the next best treatments which are in line with the findings of **Sanjana *et al.,* (2019).** NSKE found to the next best treatments, which is in line with supported by **Shyamrao*et al.,* (2018), Mourya *etal.,* (2023).** Neem oil resulted maximum shoot and fruit infestation, less effective and more expensive in controlling the pest. The results supported by **Maru *et al.,* (2018), Ghosh *et al.,* (2022).**

The data on the percent infestation of Fruit borer on brinjal on third, seventh and fourteenth day after spray revealed that all the chemical treatments were significantly superior over control. Among all the treatments lowest percent shoot infestation was recorded in Chlorantraniliprole (3.91) followed by *Emamectinbenzoate*5% SG (4.35) and Spinosad45% SC (4.61). Treatment Cypermethrin25% EC (5.13), *Beauveriabassiana* (5.31) were statistically at par with each other and treatments NSKE 5% (5.57), Neem oil 2% (5.99) were found be least effective but significantly superior over the control.

The yields among the treatments were significant. The highest yield was recorded in T7 Chlorantraniliprole (220q/ha) followed by T6*Emamectinbenzoate* 5% SG (205 q/ha), T3 Spinosad45% SC (190 q/ha), T1 Cypermethrin25% EC (160 q/ha), T5*Beauveria bassiana* (140q/ha), T4 NSKE 5% (120q/ha) and the treatment T2 Neem oil 2% (112.5 q/ha) was least effective among all the treatments. Control plot T0 (90.00 q/ha) yield.

When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was T7Chlorantraniliprole(1:8.89) followed by T6*Emamectinbenzoate* 5% SG (1:7.89), T3 Spinosad45% SC (1:7.80), T1 Cypermethrin25% EC (1:6.49), T5 *Beauveria bassiana* (1:5.81), T4 NSKE 5% (1:4.89) and the treatment T2 Neem oil 2% (1:4.45) as compared to Control T0 (1:3.86) .

Maximum cost benefit ratio (1:8.89) was obtained in Chlorantraniliprole which was supported by **Reddy *et al.,* (2022)** who reported that the Chlorantraniliprole recorded the high yield followed by*Emamectinbenzoate* 5% SG findings were supported by **Paneru*et al.,*(2020).**Spinosad 45% SCfindings reported by **Warghat*et al.,* (2020)** Cypermethrin 25%EC wassupported by **Sharma *etal*., (2017).***Beauveria bassiana*was supported by **Sarsaiya*et al.,* (2020).**NSKE5%was supported by **Singh*et al.,*(2020).** At least the cost benefit Neem oil 2%which were supported by **Naik and Kumar *(*2023)**

**Table1: To evaluate the efficacy of chemical insecticides and bio-pesticides on infestation of brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee) on Brinjal.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sr. No.** | **Treatments** | **Percent shoot and fruit infestation of Leucinodesorbonalis** | | | | | | | | | **YIELD q/ha** | **B:C RATIO** | |
| **FIRST SPRAY** | | | | | **SECOND SPRAY** | | | |
| 1st DBS | 3rd DAS | 7thDAS | 14thDAS | MEAN | 3rd DAS | 7thDAS | 14th DAS | MEAN |
| **T0** | Control | 6.53 | 7.02 | 7.42 | 7.51 | 7.32 | 7.54 | 7.89 | 7.90 | 7.76 | 90 | 1:3.86 |
| **T1** | Cypermethrin25EC | 5.82 | 5.39 | 3.78 | 4.68 | 4.62 | 5.22 | 5.00 | 5.16 | 5.13 | 160 | 1:6.49 |
| **T2** | Neem oil 2% | 6.03 | 6.08 | 5.86 | 6.03 | 5.99 | 6.03 | 5.92 | 6.01 | 5.99 | 112.5 | 1:4.47 |
| **T3** | Spinosad45%SC | 7.06 | 4.74 | 3.63 | 4.66 | 4.34 | 4.66 | 4.52 | 4.64 | 4.61 | 190 | 1:7.80 |
| **T4** | NSKE 2% | 6.18 | 6.03 | 5.42 | 5.41 | 5.62 | 5.93 | 5.32 | 5.46 | 5.57 | 120 | 1:4.89 |
| **T5** | Beauveria bassiana | 6.52 | 5.46 | 4.72 | 5.24 | 5.14 | 5.42 | 5.16 | 5.36 | 5.31 | 140 | 1:5.81 |
| **T6** | Emamectin benzoate 5SG | 6.44 | 4.57 | 3.43 | 3.95 | 3.95 | 4.52 | 4.16 | 4.37 | 4.35 | 205 | 1:7.85 |
| **T7** | Chlorantraniprole | 5.46 | 4.00 | 3.27 | 3.66 | 3.64 | 3.95 | 3.89 | 3.89 | 3.91 | 220 | 1:8.52 |
| Overall Mean | | 6.25 | 5.41 | 4.69 | 5.13 | 5.08 | 5.41 | 5.23 | 5.35 | 5.33 | ----- | ---- |
| F-test | | NS | S | S | S | S | S | S | S | S | ---- | ----- |
| S. Ed. (±) | | 0.59 | 0.34 | 0.34 | 0.21 | 0.28 | 0.42 | 0.40 | 0.41 | 0.12 | ---- | ----- |
| C.D.(P=0.05) | | 1.27 | 0.72 | 0.74 | 0.62 | 0.59 | 0.89 | 0.86 | 0.88 | 0.25 | ---- | ---- |

DAS- Days after Sowing

DBS- Days before Sowing

NS= Non-significant, S= Significant

1st Spray (% Shoot Infestation)

**Fig 1: To evaluate the efficacy of chemical insecticides and bio-pesticides on infestation of brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee) on Brinjal. (First Spray)**

2nd Spray (%Fruit Infestation)

**Fig2:To evaluate the efficacy of chemical insecticides and bio-pesticides on infestation of brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee) on Brinjal. (Second Spray)**

**CONCLUSION**

From the critical analysis and selected insecticide and bio-pesticides like Chlorantraniliprole, Emamectinbenzoate5% SG, Spinosad45% SC, Cypermethrin25% EC, *Beauveriabassiana*, NSKE 5%, Neem are showing good result against *Leucinodesorbonalis* and can be a part of integrated pest management in order to avoid indiscriminate use of pesticides causing pollution in the environment and not many harmful to beneficial insects and in increasing cost effectiveness.

**REFRENCES**

**1. Bhagwan, D. S., & Kumar, A. (2017).** Field efficacy of cypermethrin and certain biopesticides against brinjal shoot and fruit borer,(LeucinodesorbonalisGuenee) on Brinjal (Solanum melongena L.). *Journal of Pharmacognosy and Phytochemistry*, *6*(4), 1930-1933.

**2. Chakraborti, S., & Sarkar, P. (2011).** Management of *Leucinodesorbonalis*Guenee on egg plants during the rainy season in India. *Journal of Plant Protection Research*. 51 (4):325-8.

**3. Devi, L. L., Ghule, T. M., Chatterjee, M. L., & Senapati, A. K. (2015).** Effectiveness of biorational insecticides for the management of brinjal shoot and fruit borer, LeucinodesorbonalisGuenee and on yield. *Ecology, Environment and Conservation*, *21*(2), 783-788.

**4. Dongarjal, S. B. and Kumar, A. (2017).** Field efficacy of cypermethrin and certain bio-pesticides against brinjal shoot and fruit borer, *Leucinodesorbonalis*(Guenee) on Brinjal (*Solanum melongena* L.) *Journal of Pharmacognosy and Phytochemistry,* **6** (4): 1930-1933.

**5. Kolhe, P. S., Kumar, A., & Tayde, A. R. (2017).** Field Efficacy of Certain Chemicals and Neem Products against Shoot and Fruit Borer (*Leucinodesorbonalis*Guenee) on Brinjal (*Solanum melongena* L.) in Trans Yamuna Region of Allahabad. *International Journal of Current Micro-Biology and Applied Plant Sciences 6 (9): 1320*, *1327*.

**6. Kolhe, P. S., Warghat, A. N., & Mahajan, S. S. (2020).** To study the seasonal incidence of shoot and fruit borer (LeucinodesorbonalisGuenee) on brinjal (Solanum melongena L.) during Kharif season in Trans Yamuna region of Allahabad. Journal of Entomology and Zoology Studies, 8(2), 1917–1921.

**7. Kumar, A., & Thakur, S. (2017).** Comparative efficacy of essential oils, neem product and Beauveria bassiana against shoot and fruit borer, Leucinodesorbonalis (Guen.) on brinjal. Journal of Entomology and Zoology Studies, 5(4), 306–309.

**8. Lekha, S., Jat, S. K., Swami, H., & Mahla, M. K. (2018).** Bio efficacy of newer insecticide tolfenpyrad (15% EC) against shoot and fruit borer of brinjal. Chemistry Science Review & Letters, 7(26), 625–630.

**9. Marmat, C. S., &Tayde, A. R. (2017).** Efficacy of certain biorationals against shoot and fruit borer (LeucinodesorbonalisGuenee) of brinjal (Solanum melongena L.). Journal of Pharmacognosy and Phytochemistry, 6(4), 1857–1859.

**10. Maru, N. K., & Kumar, A. (2018).** Incidence of shoot and fruit borer, LeucinodesorbonalisGuen. On brinjal in relation to weather parameters in Allahabad region. Journal of Plant Development Sciences, 10(6), 323–330.

**11. Mourya, P. K., Chauhan, S., Kumar, P., & Kumar, R. (2023).** Seasonal incidence of sucking insect pests in brinjal (Solanum melongena L.). An International Journal, 15(8), 515–519

**12. Naik, S. G., & Kumar, A. (2023).** Field efficacy and economics of certain chemicals and biopesticides against brinjal shoot and fruit borer (LeucinodesorbonalisGuenée). The Pharma Innovation Journal, 12(6), 2937–2940.

**13. Palika, S. V., Vidya, S., &Tayde, A. R. (2019).** Field efficacy of some insecticides, neem oil and spinosad against shoot and fruit borer, Leucinodesorbonalis (Guen.) on brinjal. Journal of Entomology and Zoology Studies, 7(5), 563–566.

**14. Pandey, S. K., Mandloi, R., Singh, B., & Verma, A. K. (2023).** Bio-efficacy of newer insecticides against the shoot and fruit borer (Leucinodesorbonalis) of brinjal (Solanum melongena Linn.) Cv. Kavya. The Pharma Innovation Journal, 12(9), 2451–2454.

**15. Paneru, S., Bharati, S., Rijal, S., Regmi, R., Pandit, S., & Bhandari, S. (2020).** Efficacy Of Commercial Insecticides Against Fruit And Shoot Borer, *LeucinodesOrbonalis*GueneeOf Brinjal, *Solanum Melongena* L. In Dhading, Nepal. *Tropical Agro biodiversity (TRAB)*, *1*(2), 61-65.

**16. Reddy, C. S. T. S., & Kumar, A. (2022).** Efficacy of selected insecticides against brinjal shoot and fruit borer, *Leucinodesorbonalis* (Guenee). *The Pharma Innovation Journal*, *11*(4), 1327-1330.

**17. Sahu, P. K., Kumar, A., & Kujur, P. K. (2017).** Eco-friendly management of brinjal shoot and fruit borer (LeucinodesorbonalisGuenée) in Allahabad, India. International Journal of Current Microbiology and Applied Sciences, 6(10), 2814–2818.

**18. Sanjana, P. S. V. and Tayde, A. R. (2019).** Field efficacy of some insecticides, neem oil and spinosad against shoot and fruit borer, *Leucinodesorbonalis*(Guen.) on brinjal. *Journal of Entomology and Zoology Studies,* **7**(5): 563-566.

**19. Sarkar, S. U. R. A. J., Pal, S., Sahoo, S., Laskar, N., & Ghosh, J. O. Y. D. E. B. (2022**). Field efficacy study of different biorationals and insecticides against brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee) under terai region of West Bengal. *Uttar Pradesh Journal of Zoology*, *43*, 57-66.

**20. Sarsaiya, V., Gangwar, B., Kumar, P., Ahirwar, G. K., Patel, A. K., & Singh, H. (2020).** Cost benefits analysis of different bio-pesticides used for control of brinjal shoot and fruit borer (LeucinodesorbonalisGuenée) at Bundelkhand region (Uttar Pradesh). Journal of Entomology and Zoology Studies, 8(5), 640–642.

**21. Sharma, J. H., & Tayde, A. R. (2017).** Evaluation of bio-Rational pesticides, against brinjal fruit and shoot borer, Leucinodesorbonalis Guen. on brinjal at Allahabad agro climatic region. *International Journal of Current Microbiology and Applied Sciences*, *6*(6), 2049-2054.

**22. Shyamrao, N. J., Kumar, A., Patil, A. A., &Narode, M. K. (2018).** Efficacy of certain insecticides and bio-pesticides against brinjal shoot and fruit borer (LeucinodesorbonalisGuenee). Journal of Entomology and Zoology Studies, 6(5), 292–295.

**23.Singh, J. P., Singh, R. and Singh, S. (2018).** Efficacy of newer insecticides and bio-pesticides against shoot and fruit borer, *Leucinodesorbonalis*Guenee brinjal (*Solanum melongena* Linnaeus) *Journal of Pharmacognosy and Phytochemistry*, SP2: 339-347.

**24.Tripura, A., Chatterjee, M. L., Pande, R., & Patra, S. (2017).** Biorational management of brinjal shoot and fruit borer (*Leucinodesorbonalis*Guenee) in mid hills of Meghalaya. *Journal of Entomology and Zoology Studies*, *5*(4), 41-45.

**25. Yadav R., Lyall H., Kumar S. and Sanp R.K. (2015).** Efficacy of certain botanical insecticides against shoot and fruit borer, (*Leucinodesorbonalis*Guenee) on brinjal (*Solanum melongena* L.), The Bios can. 2015; 10(2):987-990.

**26.Yousafi, Q., Afzal, M., & Aslam, M. (2015).** Management of brinjal shoot and fruit borer, LeucinodesorbonalisGuenée, with selected insecticides. Pakistan Journal of Zoology, 47(5), 1413–1420.