LR-5474
[1-6]

RESEARCH ARTICLE Legume Research- An International Journal

Natural Field Parasitization of Groundnut Leaf Miner, *Aproaerema modicella* (Deventer) and Influence by Weather Parameters in Rainfed Groundnut Ecosystem

S.V. Sangeetha[1], K. Ganesan[1], R.P. Soundararajan[1], K. Malarkodi[1], M. Murugan[1], Bacham Anil Kumar[1]

10.18805/LR-5474

ABSTRACT

Background: Groundnut (*Arachis hypogea* L.) is one of the most important oilseed crops in India, playing a crucial role in the country's economy. This crop is vulnerable to various insect pests starting from vegetative to maturity phase, of which, the leaf miner *Aproaerema modicella* (Deventer) (Lepidoptera: Gelechiidae) cause substantial yield loss especially in rainfed groundnut cultivation. Most of the farmers were reluctant to adopt integrated management strategies and prefer to take up only chemical pesticides. Biological control is one of the effective management options since the groundnut ecosystem harbours several biological agents. Natural biocontrol agents including hymenopteran parasitoids like *Bracon gelechiae*, *Goniozus* sp., *Apanteles* sp., *Stenomesius japonicus* etc. plays a vital role in managing the pest under irrigated ecosystem. Only limited studies were available on the effectiveness of these natural bio-control agents in rainfed ecosystem and hence, present study was focused on the natural parasitization of *A. modicella* in rainfed groundnut ecosystem.

Methods: The field survey was conducted during *Summer* and *Kharif*, 2023 in Nambiyur block, Erode District, Tamil Nadu, India to record the natural parasitization percentage on 10 randomly selected plants at weekly interval. The parasitized larva and pupa of *A. modicella* were collected and reared under laboratory conditions to record the emergence of parasitoids The natural parasitization was correlated with the weather parameters prevailed during the cropping season.

Result: *Bracon* sp. has been identified as the major natural enemy of *A. modicella* under rainfed ecosystem. During *Summer* 2023, minimum parasitization level of 8.0 per cent was observed in the 12th Standard Mean Week (SMW) *i.e.*, second fortnight of March. Subsequently, the parasitization levels were increased during *Kharif*, 2023 with the moderate (18.00%) during 23rd to 30th SMW *i.e.*, June-July and peaked (26.00 %) during 31st to 33rd SMW *i.e.*, July-August months. The correlation analysis results revealed that the maximum temperature (0.768), minimum temperature (0.533), rainfall (0.015) and Sunshine hours (0.483) were positively correlated and Relative humidity (-0.146) was negatively correlated with the per cent parasitization.

Key words: *Aproaerema modicella*, Bracon sp., Correlation, Parasitization, Rainfed groundnut, Weather parameters.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop in tropical and subtropical regions of the world and is considered the "king of oilseed crops" in India. The global area, production and productivity of groundnut was 315 million ha, 536 million tones and 1701 kg /ha, respectively (FAOSTAT, 2020). Asia is the major groundnut producing region in the world. India ranks first in groundnut area under cultivation and is the second-largest producer in the world with 6.73 million metric tons in 2022-2023 (https://agmarknet.gov.in). In Tamil Nadu, groundnut crops cover 0.08 lakh hectares, of which 70% are covered by a rainfed crop while the remaining 30% are under irrigated conditions. Groundnut leaf miner (GLM), *Aproaerema modicella* (Lepidoptera : Gelechiidae) is an important pest of groundnut crop in India, which can cause upto 50-100% yield loss under severe infestation (Namara *et al.,* 2019). The larvae forms blister-like mines on the upper side of leaves, leading to browning, curling and eventual drying of the foliage (Ranga Rao *et al.,* 2013). In Tamil Nadu the groundnut leaf miner is a regular pest in both irrigated and rainfed groundnut with its peak infestations during the month of June-September every year (Murugasridevi *et al.,* 2022).

The diversity of parasitoid species on GLM in irrigated groundnut ecosystems was well-documented (Shanower *et al.,* 1992). The importance of biocontrol agents for successful biological control programs and the essentialities for selecting the most effective control agents was studied by Faria and Wraight (2001). Numerous

[1]Department of Agricultural Entomology, Agricultural University, Coimbatore-641 003, Tamil Nadu, India.

Corresponding Author: K. Ganesan, Department of Agricultural Entomology, Agricultural University, Coimbatore-641 003, Tamil Nadu, India. Email: ganesan.k@tnau.ac.in

How to cite this article: Sangeetha, S.V., Ganesan, K., Soundararajan, R.P., Malarkodi, K., Murugan, M. and Kumar, B.A. (2025). Natural Field Parasitization of Groundnut Leaf Miner, *Aproaerema modicella* (Deventer) and Influence by Weather Parameters in Rainfed Groundnut Ecosystem. Legume Research. 1-6. doi: 10.18805/LR-5474.

Submitted: 15-01-2025 **Accepted:** 26-04-2025 **Online**: 11-06-2025

parasitoids have been identified including *Avga choaspes*, *Stenomesius japonicus*, *Sympiesis* sp., *Tetrastichus* sp., *Chelonus* sp., *Bracon* sp., *Brachymeria* sp., *Temelucha* sp. and *Goniozus* sp. parasitizing *A. modicella* from Asia (Basha *et al.,* 2012; Murugasridevi *et al.,* 2022). Around 40 parasitoids from 12 different families have been reported to attack *A. modicella* larvae with their parasitization levels up to 50% in a single generation (Kenis and Cugala, 2006). In Southern part of India, around 25 species of hymenopteran parasitoids have been recorded parasitizing eggs, larvae and pupae of the groundnut leaf miner (Manjanaik *et al.,* 2002). But the weather parameters significantly influences the dynamics of parasitoids population and their rate of parasitization under field conditions (Thanavendan and Jeyarani, 2010). Therefore, understanding the prevalence and effectiveness of native parasitoids, as well as their relationship with local weather parameters are crucial for developing an efficient biological pest control strategy. In light of this, a study was proposed to investigate the natural parasitization and effect of weather factors on natural parasitization of *A. modicella* in rainfed groundnut.

MATERIALS AND METHODS

A field survey on natural parasitization of *A. modicella* in rainfed groundnut was conducted during *Summer* (February - May) and *Kharif* (June - August), 2023 at weekly interval in Nambiyur block, Erode district of Tamil Nadu to collect information of natural parasitization (%) of groundnut leaf miner and pooled to monthly basis. Ten groundnut plants infested with *A. modicella* larvae were randomly selected (Fig 1a). The leaves with pupae of the GLM were collected and maintained in the laboratory for 10 days by placing the leaves on wet cotton in the petriplate for observing parasitoid emergence at Department of Agricultural Entomology, TNAU, Coimbatore (Shanower *et al.*, 1992). The parasitoids emerged were preserved in 70% ethanol and observed under stereo zoom microscope (Weswox Optix SZW 85) and photographed by using stereo zoom microscope (Leica M205 A) in TNAU insect museum, Coimbatore. The morphological confirmations of the natural enemies were carried out with the help of taxonomic keys (Shaw and Huddleston, 1991). The Per cent parasitization was worked out and converted into monthly average basis using weekly data with the following formula (Murugasridevi *et al.,* 2019).

$$\text{Per cent parasitization} = \frac{\text{No. of parasitized larva / pupa}}{\text{Total no of larva / pupa}} \times 100$$

Weather data such as maximum temperature (°C), minimum temperature (°C), relative humidity (%), wind speed (km/hr), sunshine hours (hrs) and rainfall (mm) pertaining to Nambiyur block, obtained from the Agro Climate Research Centre, TNAU, Coimbatore was used for correlation studies. The natural parasitization of the experimental fields were correlated with the monthly mean values of these weather parameters.

Statistical analysis

The parasitization percent data were subjected to square root transformation and standard mean were calculated. The correlation coefficient (r) was calculated using SPSS software to determine the influence of these weather factors on the parasitization efficiency.

RESULTS AND DISCUSSION

Endophytic herbivorous insects living within plant tissues create galls like structures and mines that offer protection from predators and harsh environments while enabling selective feeding on nutrient-rich, low-defense tissues. However, leaf miners attract more parasitoid species than other insect groups due to their limited mobility, visible mines and minimal protection from the leaf epidermis (Hawkins *et al.,* 1997). The survey conducted during *Summer* and *kharif*, 2023 revealed the natural parasitization of leaf miner larvae was only by *Bracon* sp. (Fig 1a) and while no significant parasitization by other parasitoids were recorded. The parasitized samples collected from the experimental fields were maintained under laboratory and were shrank and mummified (Fig 1b). The matured parasitoid grub (Fig 1c) pupated outside of the host body (Fig 1d) and the emerged parasitoids were identified as *Bracon* sp. and confirmed by the presence of a single recurrent vein in the forewings (Fig 2) which is a distinct taxonomic character of the Braconidae family. On the contrary, (Shekharappa *et al.,* 1990) recorded 16 species of hymenopteran parasitoids on *A. modicella* during *Kharif*, 1989. While, Simithramma (1998) reported 41 species of hymenopteran parasitoids including *Bracon* sp. attacking *A. modicella*. Survey on different locations on the parasitoid fauna of *A. modicella* revealed that GLM larvae were parasitized by 13 species of hymenopteran parasitoids including four species of braconids: *Chelonus blackburni* Cameron, *Avga choaspes* Nixon, *Apanteles* spp. and *Bracon hebetor* Say. The reduced number of parasitoid species in the present study may be due to the dynamic nature of parasitoid communities, with species composition and dominance fluctuating throughout the year. In the current study, the parasitization of the groundnut leaf miner correlated with the occurrence of *A. modicella* with parasitization rates rising in tandem with higher pest infestations. This may be attributed to the continuous and staggered cultivation of groundnut in rainfed conditions, which likely contributed to the elevated *A. modicella* infestations. Additionally, the non or minimal use of insecticides in rainfed areas resulted in higher GLM populations, subsequently leading to increased parasitization rates.

At the early stage of the crop during February, 2023 no parasitization was observed. However, in early March *i.e.*,

12th SMW, a minimum parasitization rate of 8.00 per cent by *Bracon* sp. was recorded (Table 1). The parasitization rate by *Bracon* sp. on leaf miner larvae declined and ceased during late *Summer* and early *Kharif* season. Following the onset of rainfall, parasitization rates began to increase and reached a moderate level of 18.00 per cent during 23rd to 30th SMW *i.e.*, June-July and peaked at 26.00 per cent during 31st to 33rd SMW *i.e.*, July-August in the late kharif groundnut season (Table 1). The present results were supported by Subba Rao and Sharma (1966) who also

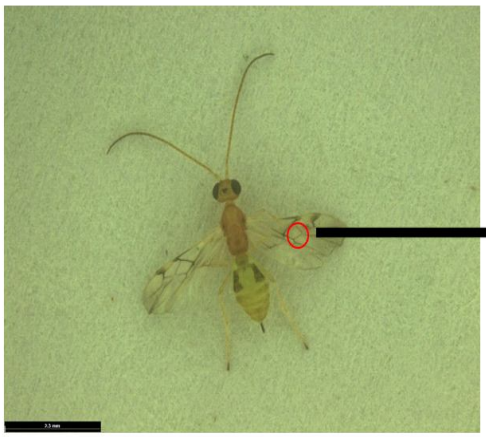
(a) Field parasitization of GLM larva

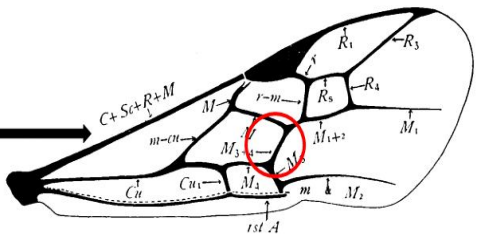
(b) Parasitized leafminer larvae

(c) *Bracon* Parasitoid grub

(d) Parasitoid pupa

Fig 1: (a-d). Natural Parasitization documented in rainfed groundnut field.





Presence of single recurrent vein represents *Bracon* sp.

Fig 2: Morphological characterization of emerged adult parasitoid.

reported 10.1-44.2 per cent parasitism by *Bracon gelechiae* under irrigated ecosystem. The other studies reported about 26% parasitism by *Chelonus sp*. and larval parasitoid *Goniozus indicus*, about 16.67% (Muthiah and Kareem, 2000).

Among the two seasons the parasitization rates were more during *Kharif*, 2023 when compared to *Summer*, 2023 (Fig 3). This was in accordance with the findings of Kothai (1974) who found that the extent of larval parasitism by parasitoids in groundnut leaf miner varied which was 30.00, 14.00, 20.00 and 23.50 per cent respectively for July, August, September and October months. Murugasridevi *et al.,* (2022) found three parasitoids *viz*., *Trissolcus. japonicus* (Ashmead), *Sympiesis* sp. and *Tetrastichus* sp. and they were most prevalent during the month of August, while the occurrence of *Chelonus* sp. was more common during the month of September. The study also found that the parasitization of groundnut leaf miner was more during rainy season when compared to summer and post rainy season. This was in accordance with earlier investigations by Yadav *et al.,* (1987) in rainfed groundnut.

As the percentage of parasitoid adult emergence is a key indicator of success in augmentative biological control (Elbehery, 2020), the parasitic effectiveness of *Bracon* sp. can be evaluated against groundnut leaf miners and considered for inclusion in biological control programs.

Understanding the adaptations of natural enemies to the change in climate is crucial for effective pest management (Thanavendan and Jeyarani, 2010). In the present study, correlation analysis of weather parameters revealed that the maximum temperature (r= 0.768*) and minimum temperature (r= 0.533*) had a significant positive correlation with *Bracon* sp. parasitism on groundnut leaf miner. However, rainfall (r= 0.483) and wind velocity (r= 0.015) exhibited a non-significant positive correlation. The Relative humidity (RH) showed a non-significant negative correlation (r= -0.117) with GLM larval parasitism (Table 2). A study conducted at Kanpur, India found that both maximum and minimum temperatures played a significant positive role in parasitization, whereas the relative humidity, sunshine and rainfall had no consistent impact on *Campoletis chlorideae* parasitizing *Helicoverpa armigera* in a chickpea ecosystem (Singh *et al.,* 2015). Similarly, a study from Pantnagar observed a non-significant positive correlation between abiotic factors and parasitism by *Campoletis chlorideae* on pod borer *H. armigera* in a chickpea sole crop. In contrast, in intercropping systems, there was a significant positive correlation with evening RH and rainfall (Jaba and Agnihotri, 2018).

Table 1: Parasitization of groundnut leaf miner by *Bracon* sp.

Natural parasitization of leaf miner - month wise (Feb 2023 - August 2023)		
Season	Months	Natural Parasitization (%)
Summer groundnut	February-March	-
	March-April	8±4.05
	April-May	-
Kharif groundnut	May-June	-
	June-July	18±4.12
	July-August	26±4.32

Table 2: Correlation of weather parameters with natural parasitization of *Bracon* sp.

Weather Parameters	% Parasitization
Maximum temperature (°C)	0.768**
Maximum temperature (°C)	0.533**
Relative humidity (%)	-0.146
Sunshine hours (hrs)	0.483*
Rainfall (mm)	0.015

*. Correlation is significant at the 0.05 level; **. Correlation is significant at the 0.01 level.

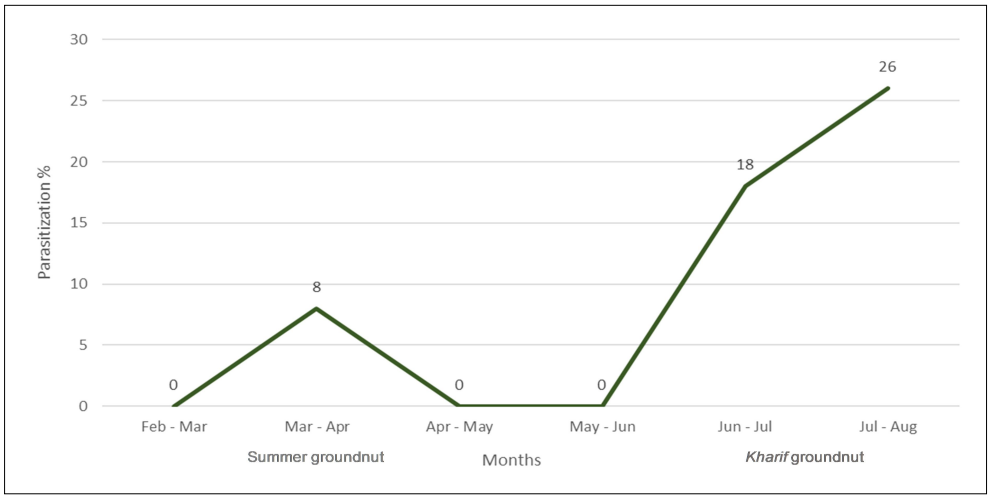


Fig 3: Natural parasitization of leaf miner by *Bracon* sp. observed during study period.

CONCLUSION

The present study evidenced that the *Bracon* sp., a parasitoid was associated with *A. modicella* was abundant and diversified in the rainfed groundnut fields under natural condition which led to high parasitism rate of more than 25 % and no significant parasitization by other parasitoids were recorded. It suggests that the *Bracon* sp. could be effectively used in augmentative biological control programs for the management of GLM. In addition, knowledge on the influence of abiotic factors on parasitism in the field is crucial for determining the sustainability of a particular parasitoids in biological control programs. Large scale and location specific study on weather parameters may also provide valuable insights into the optimal timing for field releases. Thus, *Bracon* sp. appears to be a promising biocontrol agent for augmentative biological control of groundnut leaf miners under the rainfed conditions in the near future.

ACKNOWLEDGEMENT

The authors are thankful to the Assistant Director of Agriculture, Assistant Agriculture officer and farmers of Nambiyur block, Erode District of Tamil Nadu for their extended support for successful conduct of field studies. We also express our thanks to the Department of Agricultural Entomology, TNAU, Coimbatore for providing laboratory and documentation facilities.

Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal care and handling techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

REFERENCES

Basha, H., Raju, J., Hosamani, A. (2012). Survey of parasitoid fauna on groundnut leaf miner, Aproaerema modicella deventer. BIOINFOLET-A Quarterly Journal of Life Sciences. 9(4): 435-439. https://www.indianjournals.comijor.aspx?target=ijor:bilandvolume=9andissue=4andarticle=002.

Elbehery, H., Saleh, M. and El-Wakeil, N. (2020). Propagation and application of larval parasitoids. cottage industry of biocontrol agents and their applications: Practical Aspects to Deal Biologically with Pests and Stresses Facing Strategic Crops. 49-71. https://doi.org/10.1007/978-3-030-33161-0_2.

FAOSTAT. (2020). Food and Agriculture Organization of the United Nations, Rome. p366. https://doi.org/10.4060/cb1329en

Faria, M., Wraight, S.P. (2001) Biological control of *Bemisia tabaci* with fungi. Crop protection. 20 (9):767-778. https://doi.org/10.1016/S0261-2194(01)00110-7

Hawkins, B.A., Cornell, H.V., Hochberg, M.E. (1997). Predators, parasitoids and pathogens as mortality agents in phytophagous insect populations. Ecology. 78(7): 2145-2152. https://doi.org/10.1890/0012-9658(1997)078[2145:PPAPAM]2.0.CO;2.

Jaba, J., Agnihotri, M. (2018). Relationship of abiotic factors and the copiousness of larval parasitoid, Campoletis chlorideae on pod borer, *Helicoverpa armigera* under sole and chickpea-coriander ecosystem at Pantnagar, Uttarakhand. Journal of Entomology and Zoology Studies. 6(6): 316-319. http://oar.icrisat.org/id/eprint/10960.

Kenis, M., Cugala, D. (2006). Prospects for the biological control of the groundnut leaf miner, *Aproaerema modicella*, in Africa. CABI Reviews. 9 pp. https://doi.org/10.1079/PAVSNNR20061031.

Kothai, K. (1974). Bionomics and chemical control of the groundnut leafminer, *Stomopteryx subsecivella* (zeller) (lepidoptera: gelechiidae). University of agricultural sciences, GKVK, bangalore. Ph.D. Thesis http://krishikosh.egranth.ac.in/handle/1/5810108178.

Manjanaik, C., Krishnamurthy, M., Jyothylakshmi, S., Somasundra, K. (2002). Efficacy and economics of insecticides for the management of groundnut leaf miner *Aproaerema modicella* in coastal zone. Environment and Ecology. 20(1): 99-101. https://www.cabidigitallibrary.org/doi/full/10.5555/20023030467.

Murugasridevi, K., Jeyarani, S., Kumar, S.M. (2022). Incidence of Groundnut Leafminer (GLM), *Aproaerema modicella* (Deventer) (Lepidoptera: Gelechiidae) and its parasitic fauna on alternate leguminous hosts in Tamil Nadu, India. Legume Research-An International Journal. 45(8): 1028-1035. http://dx.doi.org/10.18805/LR-4672.

Murugasridevi, K., Jeyarani, S., Mohankumar, S. (2019). Occurrence of groundnut Leafminer (GLM), Aproaerema modicella Deventer (Lepidoptera: Gelechiidae) and its parasitoid fauna in various groundnut growing areas of Tamil Nadu. Journal of Entomology and Zoology Studies. 7(5): 984-989. http://dx.doi.org/10.18805/LR-4672.

Muthiah, C., Kareem, A. (2000). Survey of groundnut leaf miner and its natural enemies in Tamil Nadu, India. International Arachis Newsletter. 20: 62-63. https://www.cabidigitallibrary.org/doi/full/10.5555/20013005709.

Namara, M., Karungi, J., Edema, R., Gibson, P., Tukamuhabwa, P. (2019). Potential for yield loss reduction and profitability assessment of pesticide control of groundnut leaf miner among soybean genotypes. African Crop Science Journal. 27(2): 183-192. https://doi.org/10.4314/acsj.v27i2.5.

Ranga Rao, G., Rameshwar Rao, V., Ghaffar, M. (2013). Handbook on groundnut insect pests identification an management. Information Bulletin. 39: 88. http://oar.icrisat.org/id/eprint/7042.

Shanower, T.G., Wightman, J.A., Gutierrez, A.P., Ranga Rao, G.V. (1992). Larval parasitoids and pathogens of the groundnut leaf miner, Aproaerema modicella (Lep: Gelechiidae), in India. Entomophaga. 37: 419-427. https://doi.org/10.1007/BF02373115.

Shaw, M.R., Huddleston, T. (1991). Classification and biology of braconid wasps. Handbooks for the Identification of British Insects. 7(11): 1-126.

Shekarappa, S., Patil, B. (1990). Parasitoid complex of the groundnut leaf miner, *Aproaerema modicella* Deventer (Gelechidae: Lepidoptera). Journal of Biological Control. 4(1): 55-56. https://doi.org/10.18311/jbc/1990/15338.

Simithramma, N. (1998). Bioecology of groundnut leaf miner, *Aproaerema modicella* (deventer) (lepidoptera: gelechiidae) and its natural enemy complex in southern Karnataka. University of Agricultural Sciences GKVK, Bangalore. Ph.D. Thesis. http://krishikosh.egranth.ac.in/handle/1/5810110357.

Singh, D., Singh, S., Vennila, S. (2015). Weather parameters influence population and larval parasitization of *Helicoverpa armigera* (Hübner) in chickpea ecosystem. Legume Research-An International Journal. 38(3): 402-406. http://dx.doi.org/10.5958/0976-0571.2015.00111.3.

Subba Rao, B., Sharma, A. (1966). Two new species of parasites reared from *Stomopteryx nerteria* (Meyrick) (Lepidoptera: Gelechidae). Indian Journal of Entomology. 28(3): 299-304. https://doi.org/10.52547/jibs.8.2.219.

Thanavendan, G., Jeyarani, S. (2010). Effect of different temperature regimes on the biology of *Bracon brevicornis* Wesmael (Braconidae: Hymenoptera) on different host larvae. Journal of Biopesticides. 3(2): 441. https://doi.org/10.57182/jbiopestic.3.2.441-444.

Yadav, D., Patel, R., Patel, R. (1987). Natural enemies of groundnut leafminer, *Aproaerema modicella* Deventer (Lepidoptera: Gelechiidae) and their impact on its infestation at Anand (Gujarat). Gujarat Agricultural University Research Journal. 13(1): 13-16. https://www.cabidigitallibrary.org/doi/full/10.5555/19881106200.