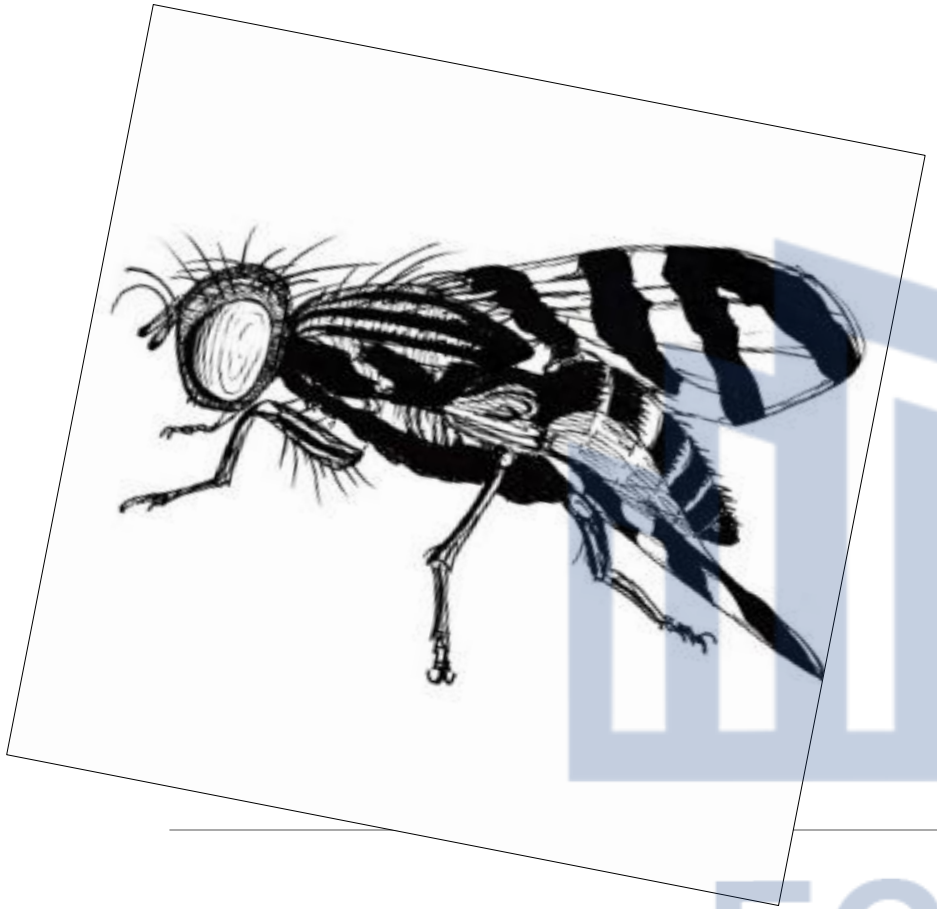


Research on the biology, ecology, damage and distribution of the sea buckhorn fly (*Rhagolethis batava* Hering, 1958) in Mongolia.

MUNKHTSETSEG. B, GANCHIMEG. G, DORJDEREM. B, TURBAT. T

Contents

Purpose

1. Study of the biology and ecology of sea buckthorn flies and identification of species

2. Study of flight activity, number density and damage of sea buckthorn flies

3. To make a map of the distribution of Seabuckthorn flies in Mongolia

Research methodology

1. The species was identified by morphological characters and PCR.

2. Fruit damage was calculated

-When fly larvae are feeding on the fruit

-One tree is selected from every 10-15 trees and 1 branch (25 cm long branch is randomly selected) is determined by scoring system

0. points (0%) – resistant (not damaged by fly larvae)

1. point - relatively resistant (0-1% of the total fruits of the branches are damaged by larvae)

1.-2.points - less damaged (2-10% of the total fruits of the branches are damaged by larvae)

2.-3. points - moderately damaged (11-30% of the total fruits of the branches are damaged by larvae)

3.-4. points - heavily damaged (31-50% of the total fruits of the branches are damaged by larvae)

4.-5. points - high damaged (>50% of all fruits of the branch are damaged by larvae)

3. The number density of flies was estimated using yellow sticky traps.

Traps were placed 3 times out of ten days during the plant growth period, i.e. in the middle of June, and the average number and density of flies caught in one trap was determined.

Species of Fruit flies

- Currently, 4350 species of 480 genera of the family ***Tephritidae*** have been recorded in all geographic regions, and approximately 850 species in the Palearctic.
- In the southeastern part of Western Siberia, 98 species belonging to 36 genera and 11 tribes were found.
- Currently, 62 species are recorded in the taxonomic database of the genus Rhagoletis Loew, 1862.

Scientists who studied Diptera insects in Mongolia (by family)

D.Myagmarsuren, N.G. Olsiufe (Diptera, *Tabanidae*)
B.B. Rodendorf, U.G. Verves (*Sarcophagidae)*
V.A. Richter (*Tachinidae, Asilidae*)
E.Narchuk (*Acroceridae, Stratiomyidae, Xylomyidae*)
V.G.Kovalev (*Empididae*)
L.V.Peck *(Syrphidae*)
L.V.Ziminia (*Conopidae)*
V.V.Zlobin *(Agromyzidae*)
E.P. Narchuk, L. (*Chloropidae*)
V.F. Zaitsev (*Phoridae, Bomyliidae, Conopidae)*
O.P. Negrobov, A.B. Barkalov(*Dolichopodidae)*
M.N. Kandybina *(Tephritidae)*
V.A. Richter (*Tephritidae)*
P.A. Ler *(Asilidae)*
B.V. Mamaev *(Cecidomyiidae)*

In Mongolia

In our country, a total of 80 species of ***Tephritidae*** **Newman, 1834** species of fruit flies were recorded in the materials of the comprehensive joint expedition between Mongolia and Russia held between 1967 and 1995.

1.Kandybina M.N. Study of fruit flies (Diptera *Tephritidae)* of the Mongolian People's Republic. Entomological review-1972. T. 51. Issue 4. pp. 909-917

2. Richter V.A. New mottled flies (Diptera *Tephritidae*) from Transbaikalia and Mongolia. Zoological Journal.1972.T.51.Issue.8.p.1251-1253

1. *Acinia nigricauda Chen.*
2. *Acanthiophilus helianthi Rossi*
3. *Campiglossa amurensis Hendel*
4. *Campiglossa grandinata Rondani*
5. *Carpomyia schineri Loew.*
6. *Chaetostomella cylindrica Robinean-Desroigg*
7. *Chaetostomella lenta V.Richter*
8. *Nitrariomyia lukjanovistshi Rodendorf*
9. *Oedaspis dichotoma Loew*
10. *Oedaspis kaszabi Richter*
11. *Orellia blanda Richter*
12. *Orellia megalopyga Hering*
13. *O.ruficauda Fabricius*
14. *O. Phagocarpus Hering*
15. *O.trimacula Hering*
16. *Phagocarpus permundus Harris*
17. *Paroxyna bidentis Robineau-Desvoidy*
18. *P.contingens Becker*
19. *P.loewiana Hendel*
20. *P.tessellata Loew*

21. Rhagoletis flavicincta Loew
22. Rhagoletis batava
23. Rh. flavivincta Loew
24. Ph. mongolica Kandybina
25. Tephrella adila Richter
26. T. basalis Hendel
27.T. caloptera Loew
28.T. serratulae Linnaeus
29.T.winnerta Frauenfeld
30.Trypeta artemisiae Fabricius
31.T. binotata Zia
32.Terellia serratulae Linnaeus
33.Urophora digna Richter
34.U.ensata Richter
35.U.mandsshurica Hering
36.Urelliosoma atroptera Dirlbek et Dirlbek
37.Xyphosia miliaria Schrank
38.Campiglossa amurensis Hendel
39.C.argyrocephala Loew
40.C.difficilis Hendel

41.C.hirayamae Matsumura
42.C.igori Korneyer
43.C.kassabi Korneyer
44.C.lubrica
45.C.luxorientis Hering
46.Pseudacinia nigricauda Chen
47.C.scedelloides Korneyev
48.C.venusta venusta Diribek et Dirlbekova
49.C.obscuripennis Loew
50.C.irrorota
51.Dioxyna bidentes Robineau-Desvoidy
52.Oxyparna diluta Becker
53.Oxyna sp.aff. guttatatofasciata Loew
54.Oxyna longicauda Korneyer,sp.n
55.O.dracunculi V.Richter
56.O.lutulenta Loew
57.Oxyparna melanostigmata Korneyer,sp.n
58.Oxyparna variabilis Chen
59.Paracarphotricha apestris
60.P.pseudoradiata Becker

61.Paranthella guttata hen
62.Orotava mongolica Korneyer
63.Psilosephala frauenfeldi Loew
64.Trupanea amoena Frauenfeld
65.T.converens Hering
66.T.stellata Fuessly
67.Terhritis euarestelloides V.Richter
68.Terhritis variata Becker
69.T.cometa cingulata Hering
70.T.corolla V.Richter
71.T.femoralis Chen
72.T.hospita V.Richter
73.T.oedipus Hendel
74.T.punctum Becker
75.Whiteina contingens Becker.comb.n
76.Whiteina locwiana Hendel, comb.n
77.Donara pennula Dirlbek et Dirlbekova
78.Gonioxyna paradigma Hering
79.Ensina sonchi Linnaeus
80.Noeeta alini Hering

Zoologishen Museum, Reichenbachia

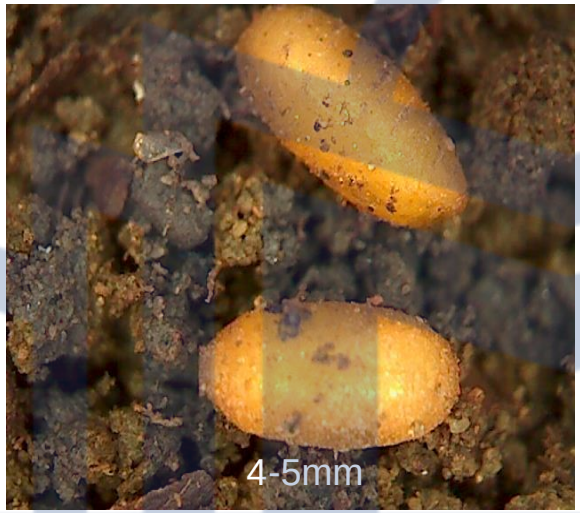
Taxonomy (№670624)

Species: Seabuckthorn fly -*Rhagoletis batava* Hering, 1958

= *Rhagoletis obscuriosa* Kolomiec., 1970

Rhagoletis batava was first determined ed by Hering in 1958.

Later determined by Rohdendorf, 1961: Kandybina, 1977:
White & Elson-Harris, 1992, Merz, 2001: Norrbom et al., 1999: Smit, 2010



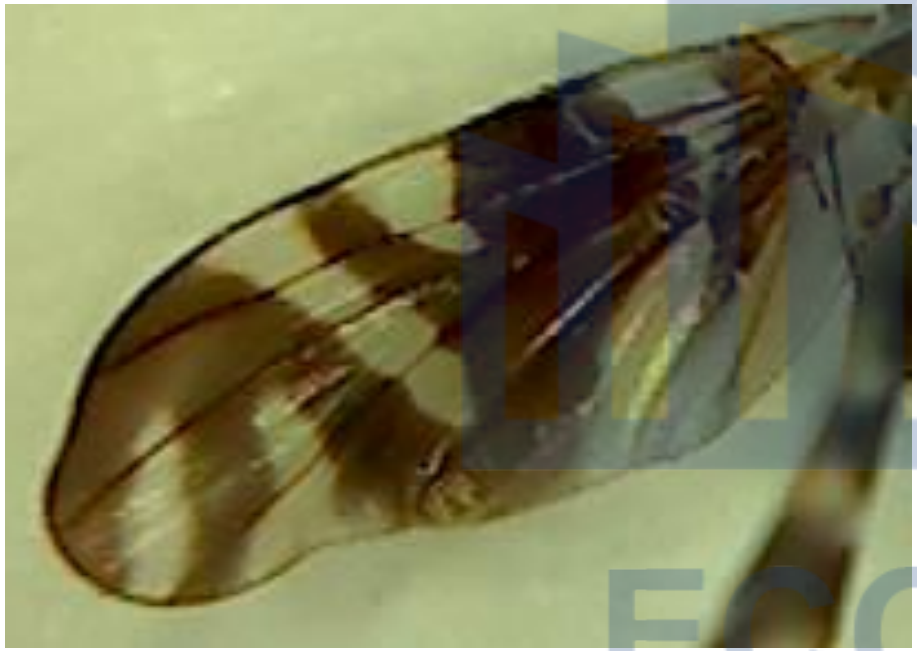

а: larva б:pupa, в: adult male, adult female

Research results

order; (Diptera), family; (*Tephritidae* Newman, 1834),

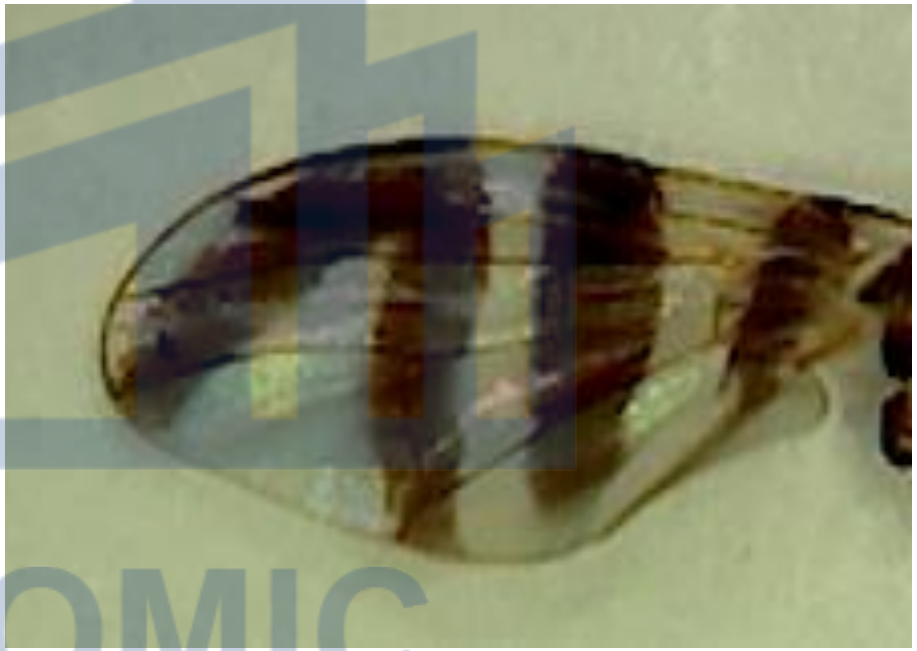
The species ***Philophylla caesio*** (Harris, 1780) of the genus Philophylla (Persson, 1958) was first discovered in natural sea buckthorn fields.

Species differences



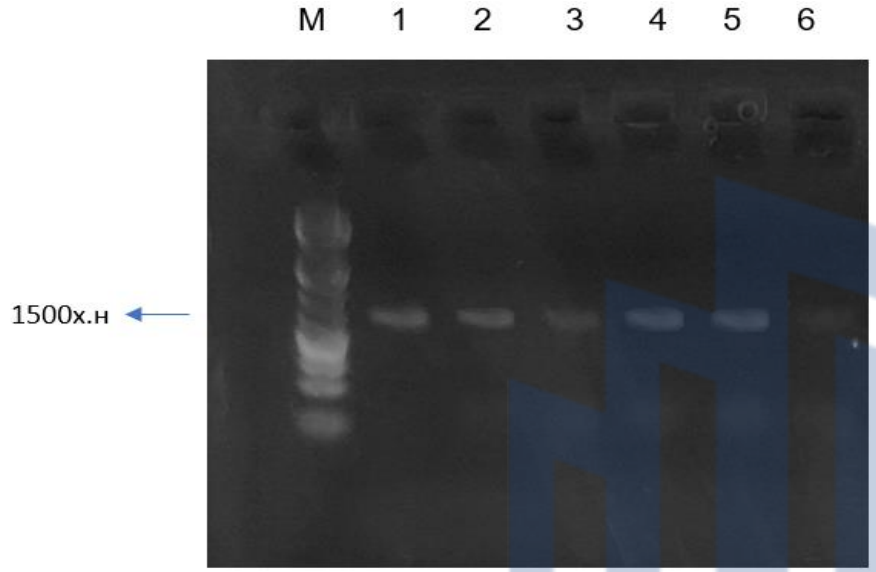
Philophylla caesio fly wings and veins/ *eScope. Handmicroscope*

photo by B.Munkhtsetseg. .2019.10.10



Rhagoletis batava fly wings and veins. eScope. handmicroscope *(photos by B.Munkhtsetseg.2019.10.10)*

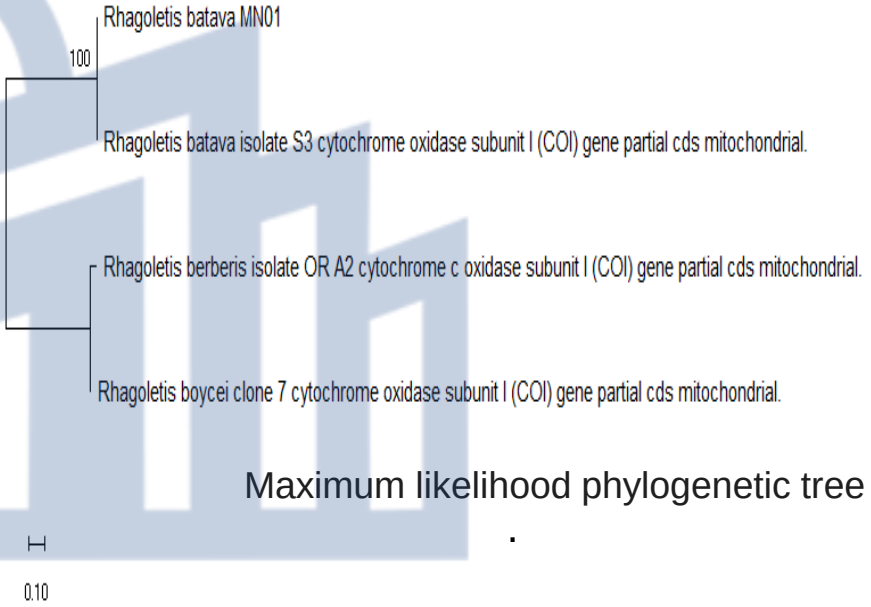
Zavkhan province. Durvulji. Khar but



M-Маркер 10000х.н,4-р нүхэнд *Rhagoletis batava (1500х.н)*

C1-J-1718[1] 5' GGAGGATTTGGAAATTGATTAGTTCC, 3'
C1-N-2191[1]-5' CCCGGTAAAATTAA AATATA AACTTC 3'

Rhagoletis batava: Phylogenetic tree



Maximum likelihood phylogenetic tree method

.

For comparison, gene MT015673.1 was in cluster 1 with *R. batava* with bank no.

This confirms that it is *R.batava.*

Number registered in Genbank– OL757571 (*R.batava*)

J. Temuujin 2021

In 1970, Kolomyetz considered the Siberian buckthorn fly as a new subspecies. ***RHAGOLETHIS BATAVA OBSCURIOSA*** (KOLOMIEC,1970)

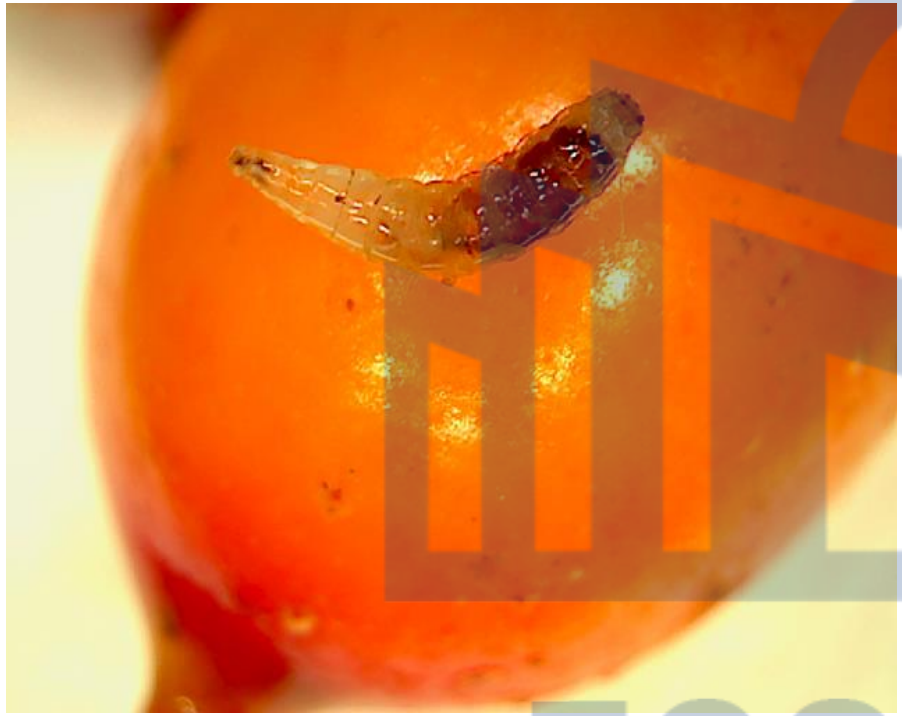
He believed that the Siberian fly species was a different species that differed in symptoms from the European species, so he made it a subspecies. However, it was not proven that the species spread in Siberia is a subspecies, so it is considered a single species that spread from Siberia to Europe.

The Siberian species is highly adaptable and more aggressive, and several factors are believed to have contributed to its spread to Europe.

Among them: Climate change or humid and warm climate had a favorable effect on reproduction.

It is also related to the increase in the amount of fodder or sea buckthorn cultivation

Damage



Usually 1-2 fruits are damaged, but in some cases they feed on up to 5 fruits.
There are 1-2 larvae per fruit, but up to 4 larvae can occur.

(B.Munkhtsetseg 2021.09.03)

Fruit damage

In the first ten days of September 2019, damage caused by sea buckthorn fly larvae was estimated in a 10m2 area of the Khar but in Durvuljin Sum, Zavkhan province, and the total fruit damage spread to 96.8% of the sea buckthorn reached 85-95%, and the spread of fly larvae reached 63.3% in Ulaan Buraa grove damage had reached 80%

	Name of place	10м^2 талбай			
		Total number of trees counted	Number of damaged tree by fly larvae	Distribution, %	Damage ,%
1	Zavkhan. Durvuljin soum. Khar but	63	61	96.8	85-95
2	Zavkhan. Durvuljin soum. Ulaanburaa	30	19	63.3	75-80

When compared with the damaged fruit and healthy fruit from branches with damaged fruits by sea buckthorn fly larvae, 82.8% of the fruits on average 25 cm long branches were damaged, and 77.2% of the leaves were deformed

2021:2 ha. Sea buckthorn field in ABBA-4 company, Jargalan soum, Khovd province. (N48^{0}00”01.5/E91^{0}35”39.5.Д.т.д:1410m)

-From the first ten days of July, the density of the number of flies in the insect sticky trap was 96-101 individuals per trap.

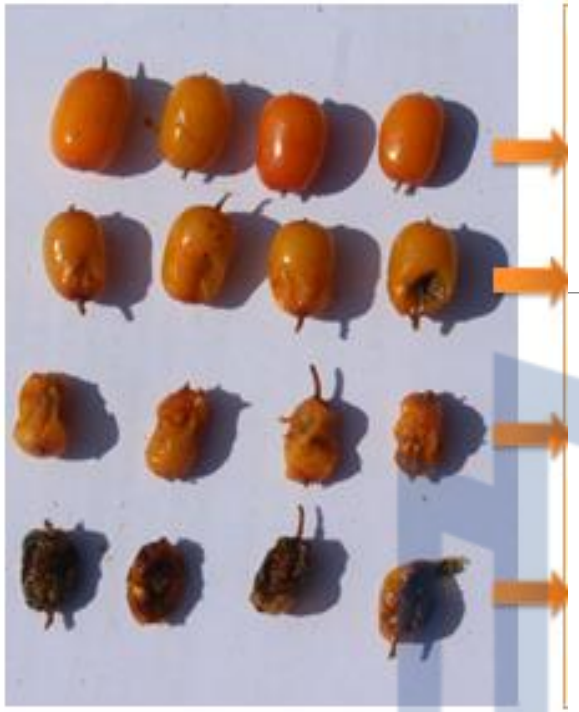
(B.Munkhtsetseg Khovd, Jargalan. 2021.08.09).

3 replicates were obtained from branches with larval damaged fruits.
When comparing damaged fruits and healthy fruits, 71.4% of fruits on average 25 cm branches were damaged.

Healthy fruit and damaged fruit were compared

When picking fruits damaged by fly larvae

Branch 1: Larvae infected fruits, 33 pieces
Branch 2: Larvae infected fruits, 13 pieces
Branch 3: Larvae-infected fruit, 42 average = 29.3pieces
Branch 4: With healthy fruit or control = 41 pieces



Healthy fruits

The first symptom of fruit damage by larvae

The fruit will shrivel

After the larvae emerge from the fruit, they turn black and dry

Changes in yield weight of fruits with different degrees of damage

Inya сорт.2009 (Lyubov, Shamanskaya 2015).

Indicator	Healthy fruit	Weight loss of damaged fruit, %										
		1	10	20	30	40	50	60	70	80	90	100
100 fruits weight (g)	92.7	92.5	89.5	86.7	84.0	8.8	79.8	73.5	70.3	67.1	63.9	60.5
Compared to control (%)	-	99.7	96.5	93.5	90.6	88.2	86.0	79.2	75.8	72.3	68.9	65.2
Yield loss (%)	-	0.3	3.5	6.5	9.4	11.8	14.0	20.8	24.2	27.7	31.1	34.8

-M. A. Prokofieva studies; The sum of effective temperature for pupal development is 312 C and the variation is ±67.5.

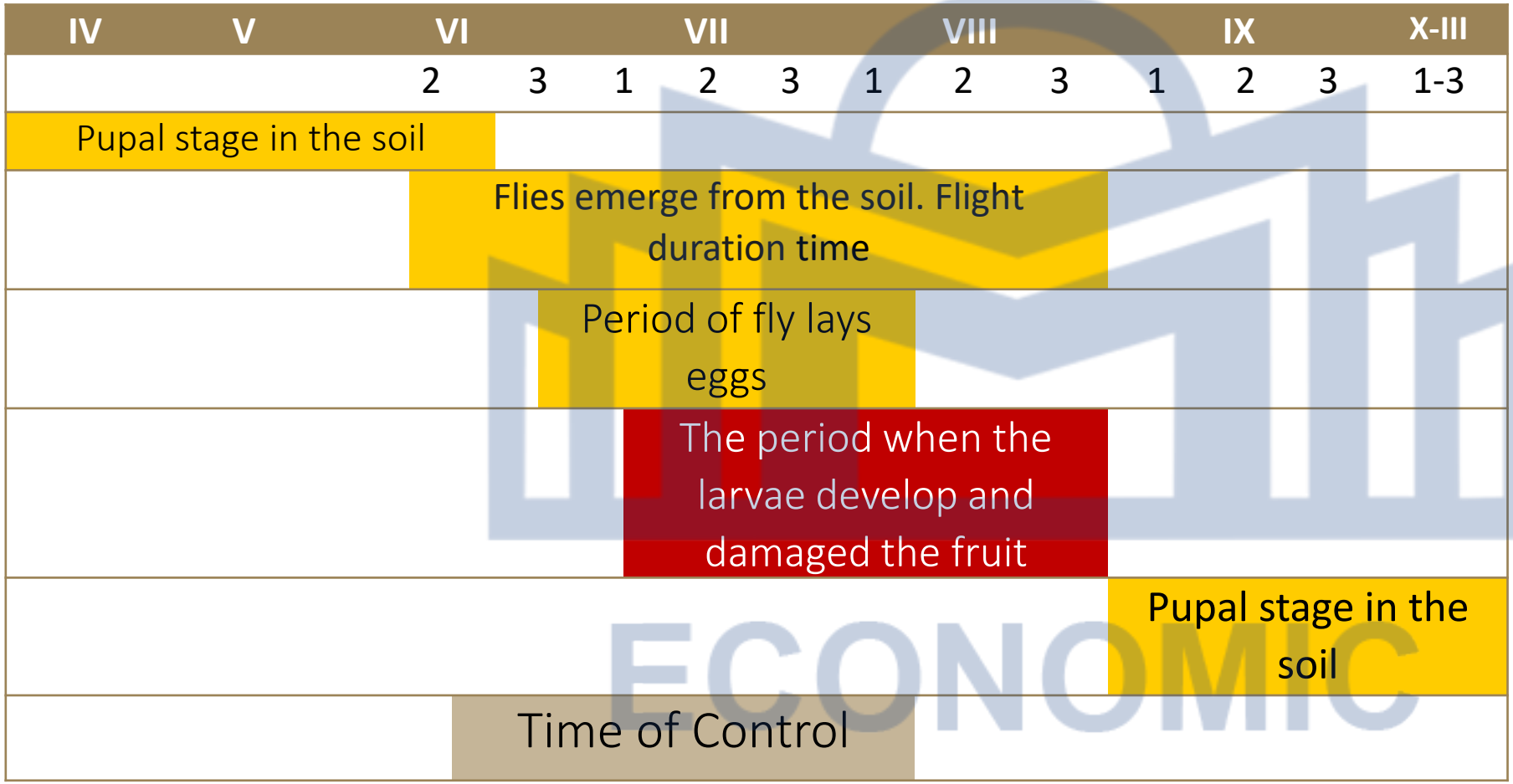
The sum of effective temperature in flight adult fly is 252.1-319C. It was found that the egg laying is 339.5-390.3 C, larval development is 428.3-470.0 C, and one generation give 48-57 days (Zeynalov A.S 2018).

The early emerge of flies starts when the spring of the year is warm, the first ten days of June are hot or sunny, and the sum of useful heat is 336-3800C, or June 9-22.

The mid-term distribution is that the sum of effective temperature in the middle ten days of 6 months is 271-278 C, or the distribution of flies continues during the cool season.

The end of the 6th month and the beginning of the 7th month are considered to be the beginning of the evening distribution. In that year, the cold period of spring continued, and the sum of useful heat was 250 C.

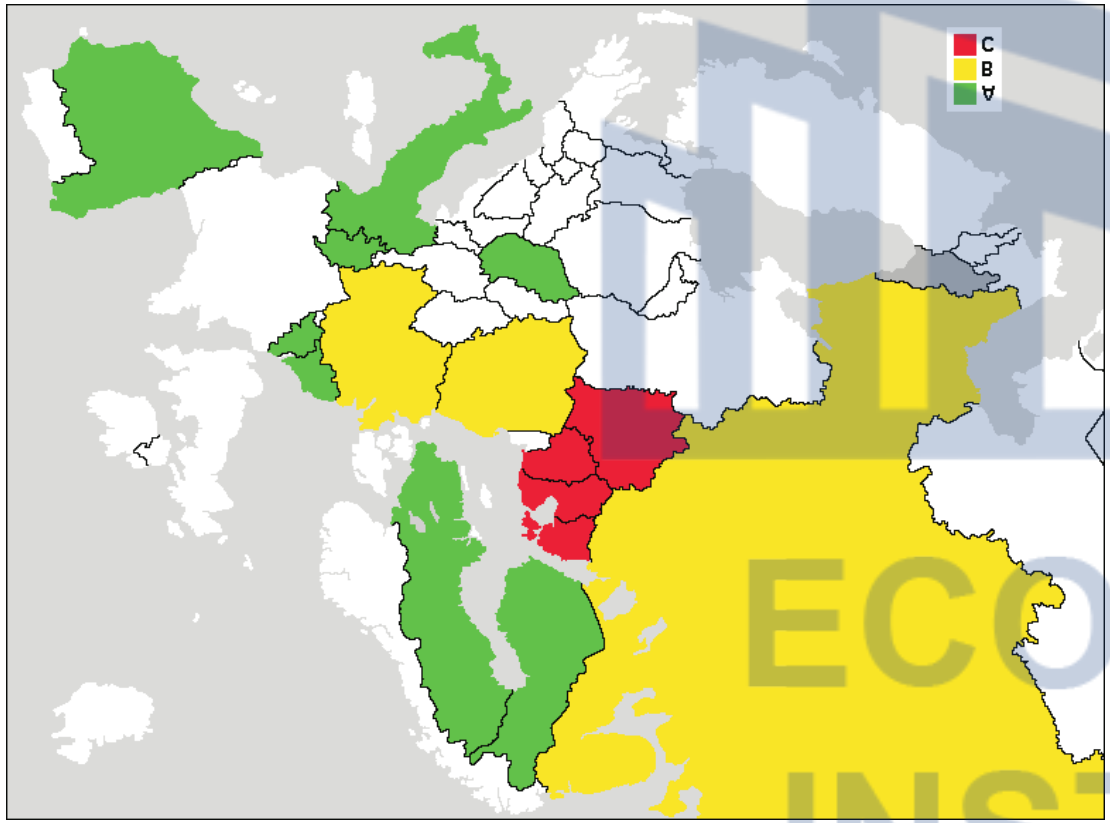
Phenology



Sea buckthorn flies emerge from the pupa from the third ten days of June and continue their development.
From the third ten days of August, they transition to the pupal stage and overwinter.

Seabukhtorn fly developed 1 generation per year in western region of Mongolia

Distribution



European distribution of the sea buckthorn fly

(A-green: native species,
B-yellow: possibly alien with native distribution,
C-red: alien species)
www.researchgate.net/figure/European-distribution-of-Rhagoletis-batava

Netherlands, Switzerland, Spain, Russia (North Caucasus, Altai, Tuva, Kyrgyzstan (Korneyev V.A, Mishustin R.I, Korneyev S.V 2017). Armenia, Belgium, Belarus, Finland, Estonia, Germany, Hungary, Italy, Kyrgyzstan, Latvia, Lithuania, Poland, the European part of the Russian Federation,Sweden, Switzerland, Spain, the Netherlands, Turkey, the North and Central Caucasus, the southern mountains of Siberia, Altai and Tuva (Burcu ÖZBEK ÇATAL, Asime Filiz ÇALIŞKAN KEÇE2, Mehmet Rıfat ULUSOY 2019)

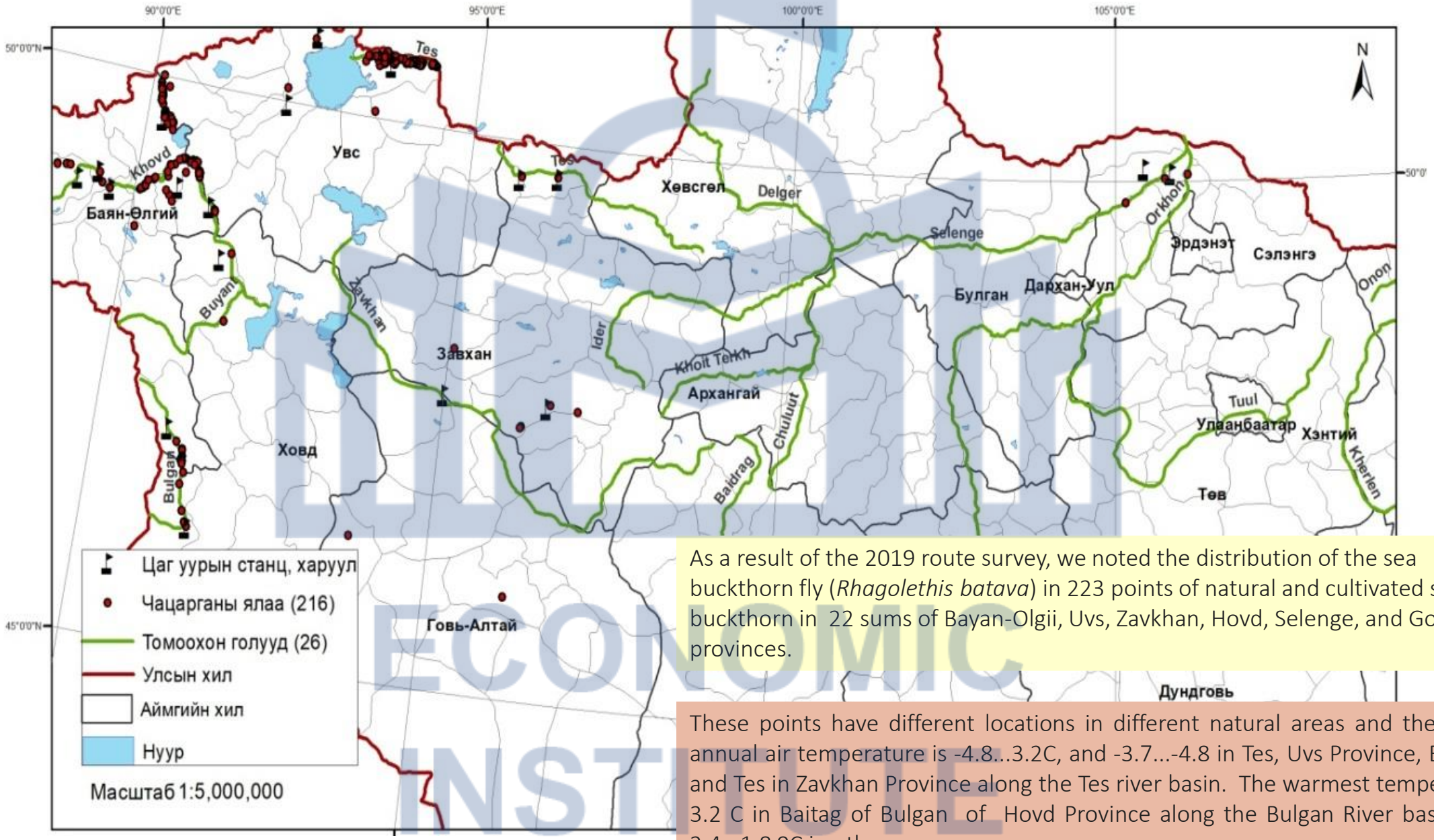
Distribution of the sea buckthorn fly: The fly was first described in the Netherlands (Hering,1958) and was known in a few European countries, but was not particularly harmful. However, it was particularly harmful to sea buckthorn cultivation in Western Siberia and Altai region (Kolomietz, 1970; Shamanskaya, 2006).

Since 2001, the intensive outbreak of the fly has been observed in the European part of the Russian Federation. Soon, it began to seriously damage crops in Belarus, Latvia, Lithuania, Germany, and Poland in 2014.

In 2015, it was recorded in the sea buckthorn fields of Estonia and Finland, and it was detected in Hungary during the same year during the monitoring study.
This is the basis for confirming that it spread from Siberia to Europe.

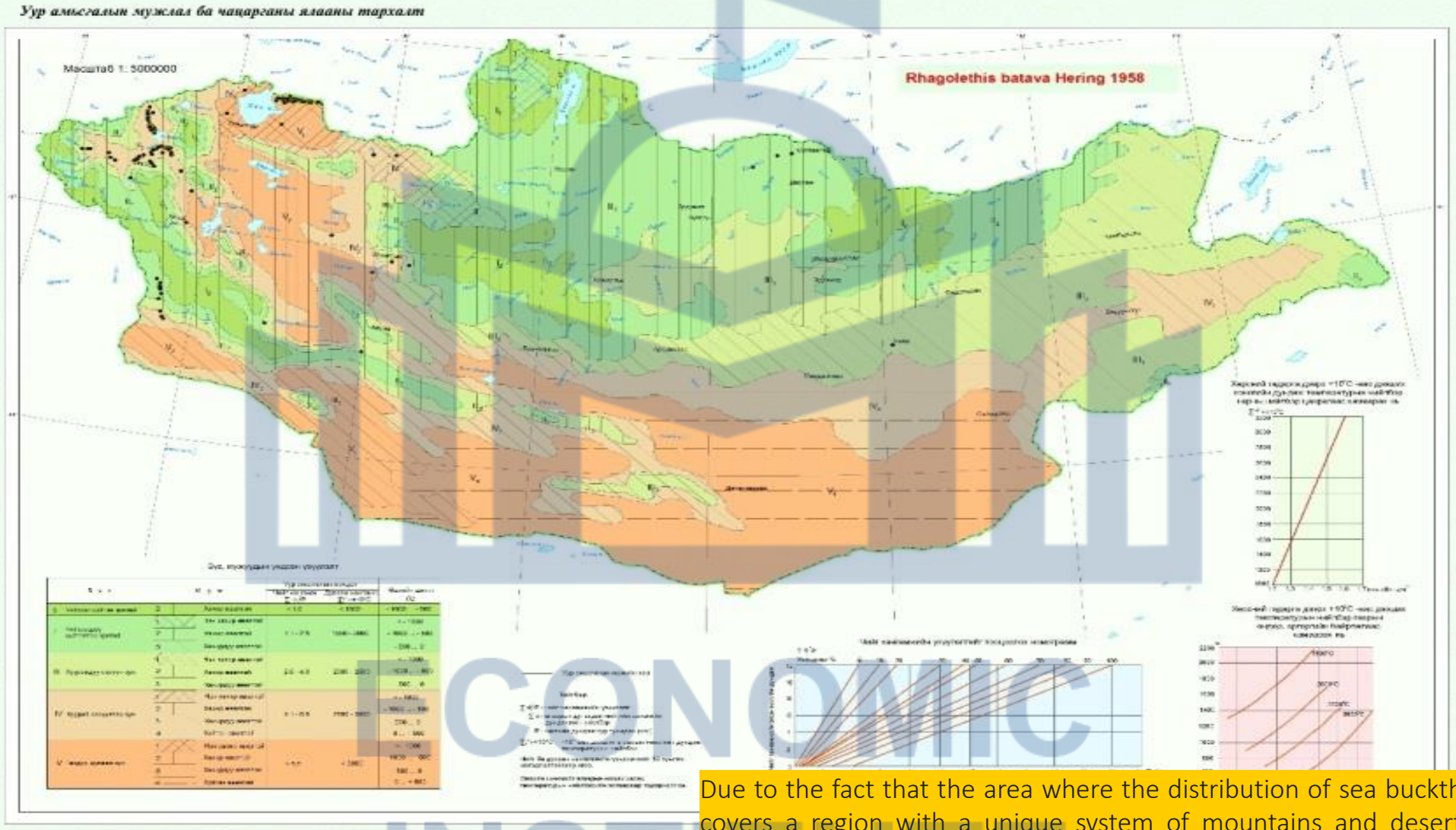
In Mongolia

It is a Palearctic species and is distributed in the depressions of the big lakes of our country, in the forest steppes, in the valleys of large rivers, around the Uvs lake, in the basins of the Kharkhiraa, Turgani rivers, Hovd rivers, Bulgan rivers, and Zavkhan rivers.



As a result of the 2019 route survey, we noted the distribution of the sea buckthorn fly (*Rhagolethis batava*) in 223 points of natural and cultivated sea buckthorn in 22 sums of Bayan-Olgii, Uvs, Zavkhan, Hovd, Selenge, and Gobi-Altai provinces.

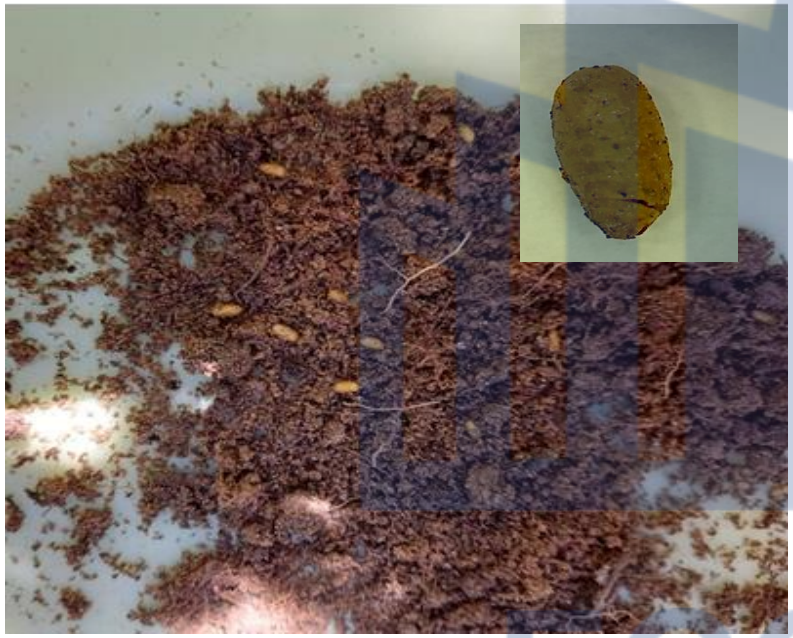
These points have different locations in different natural areas and the average annual air temperature is -4.8...3.2C, and -3.7...-4.8 in Tes, Uvs Province, Bayantes, and Tes in Zavkhan Province along the Tes river basin. The warmest temperature is 3.2 C in Baitag of Bulgan of Hovd Province along the Bulgan River basin, and -2.4...1.8 0C in other.

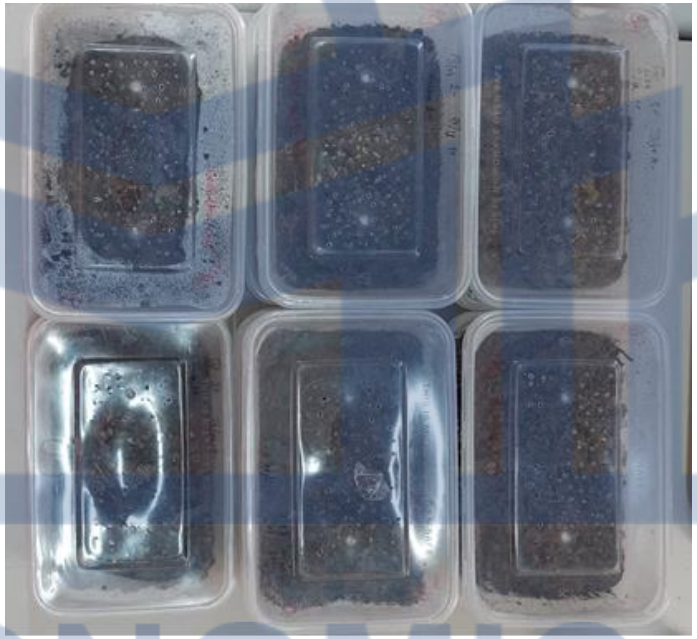


Due to the fact that the area where the distribution of sea buckthorn fly is marked covers a region with a unique system of mountains and deserts combined, the amount of rainfall is not uniform, and most of the area is in a dry and cool climate, and some parts are in a cold, humid region

From the field of sea buckthorn cultivated in Jargalan, Hovd province, and Ulagom sum, Uvs province

4125 pupa samples were collected from a total of 30 points in the first ten days of June. - The density of pupae in the soil per 1m2 area; 25.5 in Uvs province and 22.8 in Hovd province





-When the pupae were placed in the laboratory twice for 60 days (under conditions of 220 C, 60% humidity and normal lighting), 51.7% of the total 4125 pupae matured.

-48.2% of the total number of pupae was reduced.

Natural enemies

Order: Hymenoptera
Family: *Pteromalidae*
Genus: Habrocytus

Habrocytus sp..

Order: Hymenoptera
Family: *Braconidae*
Genus: Opius

Opius rhagoleticola Achtleben, 1934

The number of parasites per host insect was 1:1.

Conclusions

1. 2 species of Rhagolethis fruit fly were noted.
2. *Rhagoletis batava* was identified by PCR and registered in the gene bank .
3. The phenology of the sea buckthorn fly was determined in the western region of Mongolia.
4. We recorded the distribution of the sea buckthorn fly (*Rhagoletis batava*) at 223 points in 22 sum areas of 6 provinces of Mongolia and recorded it on the distribution map.
5. The area where the sea buckthorn fly is distributed is in the dry cooler climate, and in some places it is in the cold humid region.
6. Improved internal quarantine measures are needed to limit the spread of the sea buckthorn fly

Thank you