

ノウサギ(*Lepus brachyurus*)の食性

愛媛県産ノウサギの胃内容物分析

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論文

The Food Habits of the Japanese Hare
(*Lepus brachyurus*) (I)

Stomach Content Analysis of Hares from Ehime Prefecture

Shin-ichi HORINO* & Tsutomu KUWAHATA**

HORINO, Shin-ichi & KUWAHATA, Tsutomu: **The food habits of the Japanese hare (*Lepus brachyurus*) (I) Stomach content analysis of hares from Ehime Prefecture** J. Jap. For. Soc. 66: 347~352, 1984 Japanese hares (*Lepus brachyurus* TEMMINCK) were collected from Ehime Prefecture in March, 1979, and their food habits were studied by means of stomach content analysis. The stomach contents were treated with nitric acid for the cleaning of plant fragments. Plant fragments were identified with reference slides under a microscope, and were classified into 18 items. The amount of each item was estimated as the proportion of the item to all the items on the slide. First, the average percentage of each item for all the hares as a group was determined. The amount of *Cryptomeria japonica* D. DON was as much as 13.1%, while no fragments of *Chamaecyparis obtusa* S. et Z. was found despite the fact that both species are damaged by hares. The difference of the amounts of the two species seems to correspond to the variety in the eating habits of the animal. From the quantitative viewpoint, their main food was many species of Gramineae (47.7%). Second, the amounts taken were reexamined according to categories of sex and pregnancy. The amount of *C. japonica* showed a notable difference among the categories. Pregnant females ate the plant in a high percentage (20.1%). But non-pregnant females ate less of it than males did (7.7% and 11.8%, respectively). This fact suggests that the difference might be caused by the physiological change that pregnancy induced.

堀野眞一・桑畑 勤: ノウサギ (*Lepus brachyurus*) の食性 (I) 愛媛県産ノウサギの胃内容物分析 日林誌 66: 347~352, 1984 愛媛県で1979年3月に採集されたノウサギの食性を胃内容物分析によって調査した。胃内容物を硝酸で処理した後、その中の植物片をリファレンスプレパレートを用いて同定し、18項目に分けた。定量化は、植物片の面積を測定し、その百分率を求めることによって行った。その結果、まず全体を見ると、胃内容物の13.1%がスギで占められていた。一方、ヒノキはスギと同様に野兎害を受けているにもかかわらず検出されなかったが、この原因は現在のところ不明である。量的に見たときの主食はイネ科植物であり、これには多くの種類が含まれていた。次にノウサギを性と妊娠の有無でグループ分けした。すると、スギの摂食量が妊娠雌において多く(20.1%)、非妊娠雌(7.7%)では雄(11.8%)よりも少量であった。この差は妊娠雌がスギを選択的に摂食している可能性を示している。

I. Introduction

The Japanese hare (*Lepus brachyurus* TEMMINCK) damages man-made coniferous forests (1). To prevent damage by this animal, many ecological studies were made, but most of them were concerned with population dynamics. The food habits of the Japanese hare are rarely studied.

However, the present report is about the food habits of the Japanese hare determined by means of stomach content analysis so as to understand the ecological role of the hare and to obtain fundamental data for controlling it. The authors preparatorily reported on reference slides which are necessary for stomach content analysis (2). The hares for study were collected in Ehime

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Prefecture where the man-made coniferous forests are considerably damaged by this animal.

II. Methods

1. Preparation

The hares were collected in Matsuyama City and neighbouring areas in Ehime Prefecture, in March, 1979. These areas are hilly, ranging from 100 to 400 m in altitude. The vegetation forms a mosaic of man-made forests of *Cryptomeria japonica* D. DON and *Chamaecyparis obtusa* S. et Z., secondary forests of *Pinus densiflora* S. et Z., mixed forests, and farms. Field observations in these areas were made at the beginning of April, 1982, to find hare damage.

Hares were dissected by the staff of Ehime Prefectural Forestry Research Station, and their digestive tracts and reproductive organs were fixed with five percent formalin solution. Sent to the authors, these materials were processed as follows.

About one gram of stomach contents was placed in a 50 cc beaker with 20 percent nitric acid. It was heated at a little lower temperature than the boiling point for about one hour, and then was kept at about 60°C until the acid dissolved the viscous matrix that interferes with identifying the plant fragments (The time needed for this treatment varied from hare to hare, ranging from three hours to several days). Then the material was washed with water, and mounted on microscope slides, using APATHY's gum syrup. Dying was omitted.

2. Identification

Materials were observed with a NOMALSKY's differential interference contrast microscope of 200 magnifications. There are some differences of the images between a NOMALSKY's microscope and a common biological microscope, especially in color. By comparison with the reference slides (2), all the plant fragments were identified. Strictly speaking, identification should follow the classification that the taxonomists present. However, most of the fragments were too small to show enough key characteristics for identification that it was obliged to be more approximate than it should have been.

3. Quantitative analysis

The amount of each plant item in the hare stomachs should be measured as dry weight, if possible. However, it was very difficult to do this with the minute plant fragments so that the amount was estimated by measuring the area occupied by the fragments with a microscope micrometer. Also it was so difficult to measure the area of all the fragments that a mean area

Table 1. Plant species damaged by the hares in the area where the hares were collected

Species	Japanese name
<i>Eurya japonica</i> THUNB.	Hisakaki
<i>Camellia japonica</i> L.	Tsubaki
<i>Mallotus japonicus</i> MUELL.	Akamegashiwa
<i>Akebia quinata</i> DECNE.	Akebi
<i>Kadsura japonica</i> DUNAL	Sanekazura
<i>Rubus hirsutus</i> THUNB.	Kusaichigo
<i>Rosa multiflora</i> THUNB.	Noibara
<i>Elaeagnus pungens</i> THUNB.	Nawashirogumi
<i>Cinnamomum japonicum</i> SIEB.	Yabunikkei
<i>Cymbidium virescens</i> LINDL.	Shunran
<i>Pinus thunbergii</i> PARL.	Kuromatsu

for each item was measured. Thus, the total area of an item is the product of its frequency and its mean area. For each hare stomach, at least two slides were prepared and measured, and the average value of these measurements were calculated for each hare stomach and for each item.

III. Results and Discussion

1. Field observations

Table 1 shows the plant species damaged by the hares in the areas where the hares were collected for the study. Of these plants, *Mallotus japonicus* MUELL. was the most heavily damaged. This list does not agree with the stomach contents perhaps because the hares were collected from a much wider area than the area where the damage observations were made. This list will be useful to identify hare food in the future.

2. Stomach-content analysis

The plant fragments in the hare stomachs were classified into 18 items. Their botanical names have not been known, so are called by assumed names, with some exceptions. Description and explanation of the major items are as follows:

1) *Cryptomeria japonica* D. DON

Epidermis yellowish, thick. Cell walls thick. Epidermal cells 4~5-gonal, 20~30 μ m in diameter in stomatal region: oblong, 40 μ m long, 15 μ m wide in other regions. Stomata oval, 39~51 μ m long, 27~33 μ m wide (Epidermal cells of this plant are similar to those of *Chamaecyparis obtusa* S. et Z. The two plants are distinguished from each other by stomata size and shape. Stomata of *C. obtusa* are 28~35 μ m in length and 20~30 μ m width) (Fig.1 (A)).

2) Gramineae [A]

Epidermal cells 50~70 μ m long, 20 μ m wide, colorless, highly transparent. Stomata 35 μ m long, 20 μ m wide (Fig.1 (B)).

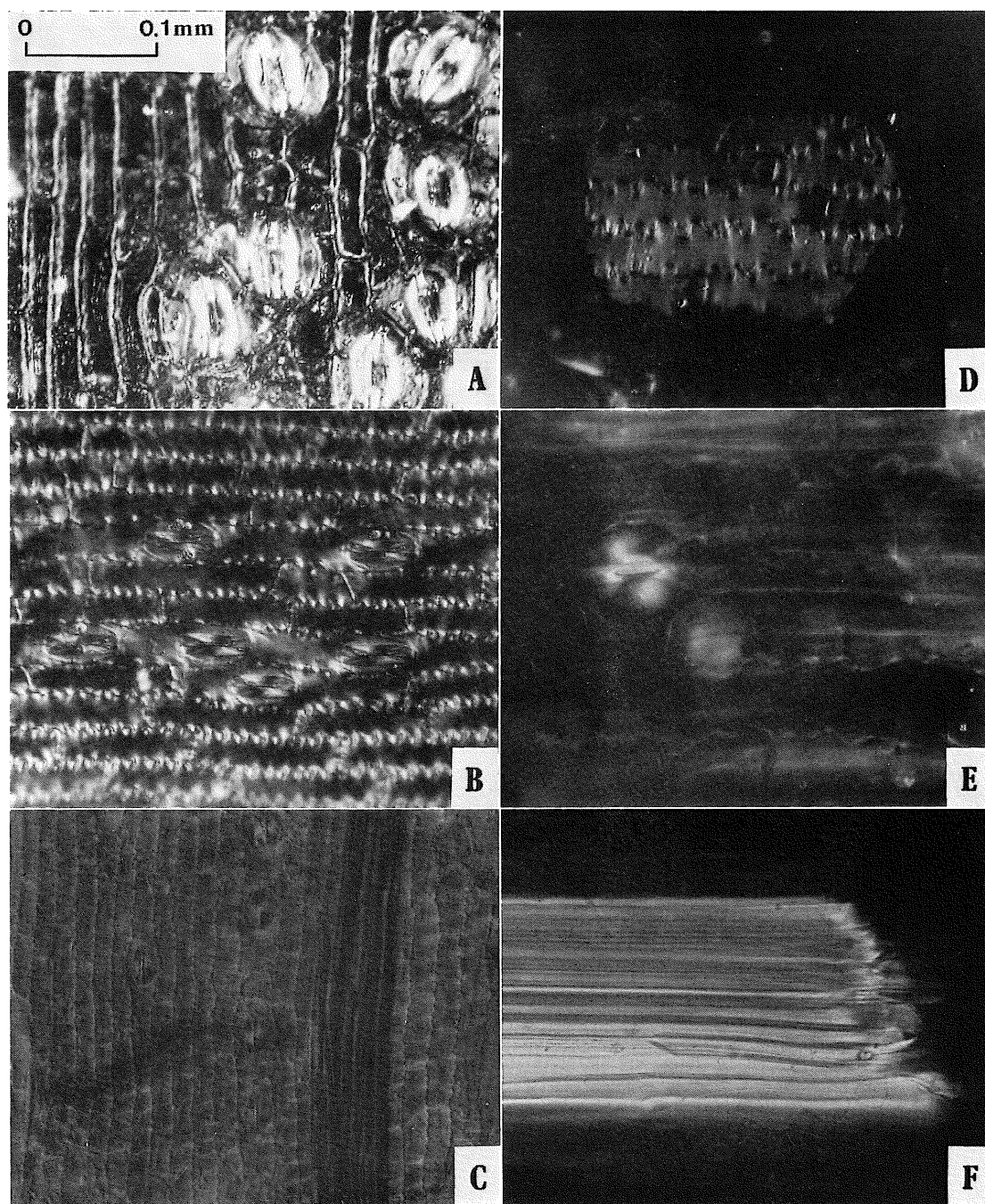


Fig. 1

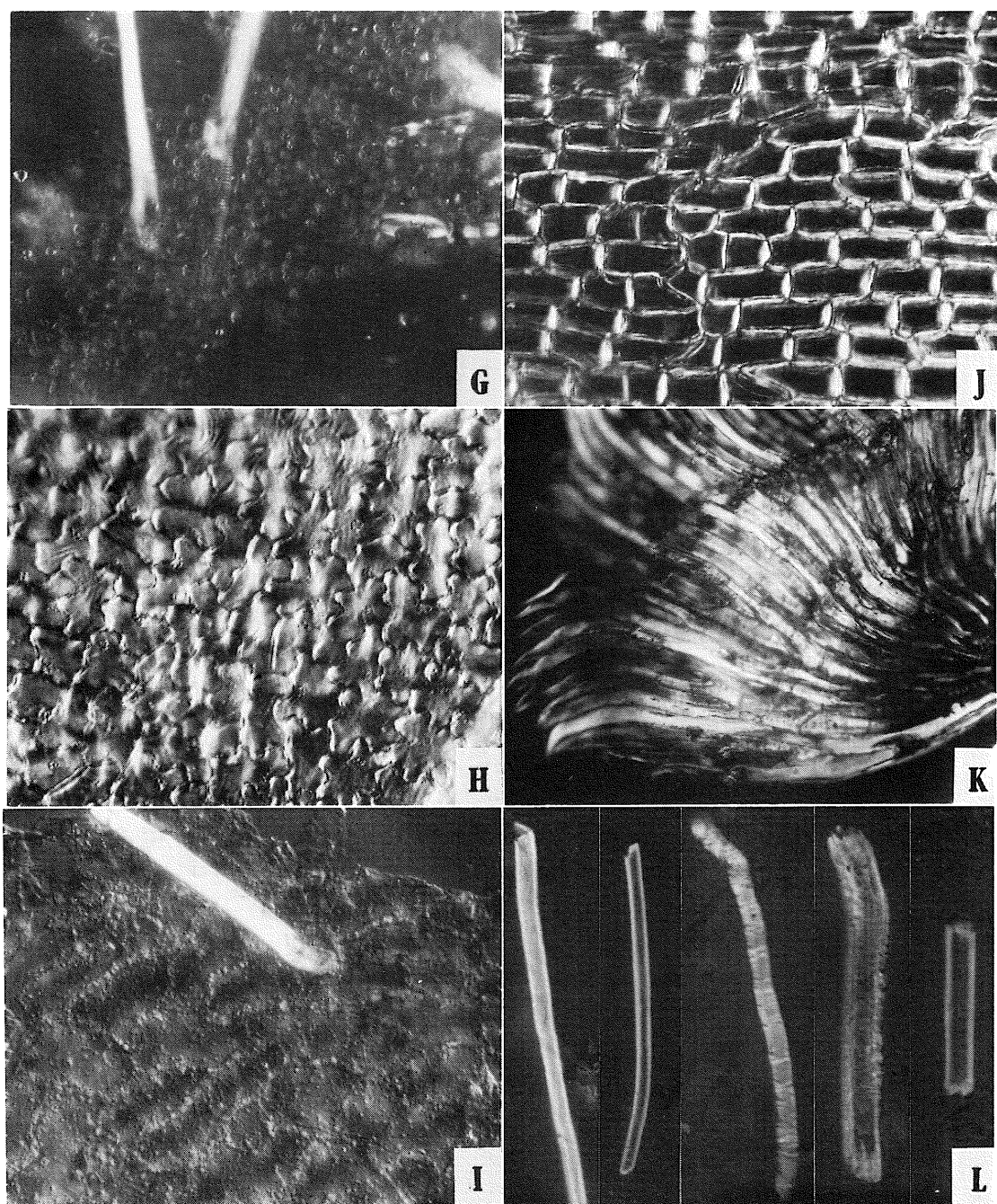


Fig. 1. Plant fragments in the hare stomachs
See text for explanation.

3) Gramineae [DE]

On the surface, epidermal cells fine, small, long, colorless, sometimes yellowish. Parenchyma cells 10 μm in diameter. Stomata 22 μm long, 17 μm wide. On the reverse surface, epidermal cells large, 120 μm long, 30 μm wide, colorless, highly transparent. Cell walls roughly wavy (Fig.1 (C), (D)).

4) Gramineae [DK]

Epidermal cells large, round, transparent. Hairs unicellular, long, thick. Stomata round, 50 μm in diameter (Fig.1(E)).

5) Gramineae, fiber bundle

Rainbow-colored. Cut ends jagged (Fragments of fibrovascular bundle, often accompanied by a bit of epidermis or trichomes whose shapes are unique to Gramineae.) (Fig.1 (F)).

6) Dicotyledon [F]

Epidermal cells hardly visible. Hairs unicellular, long, very thin except for their bases. Stomata small, hardly visible. Vascular bundles and granules fine (Fig.1 (G)).

7) Dicotyledon [K]

Epidermal cells on the stomatal surface resembling those of *Clematis terniflora* DC., about 40 μm long. Cells on the opposite surface resembling to those of *Rubus* spp., colorless, transparent. Hairs unicellular, large (Fig.1 (H)).

8) *Rubus*?

Epidermis moderately thick. Epidermal cells 4~5-gonal, 20~30 μm in diameter on the adaxial surface, a little smaller on the abaxial surface. Hairs unicellular, long, thin (Most of these fragments were identified as epidermis of leaves of *Rubus* spp., but some lacked enough evidence.) (Fig.1 (I)).

9) Dicotyledon [PA]

Cells uniform in shape and size, rectangular, 30 μm long, orange-colored to pale yellow (Perhaps this item was cork-tissue of some dicotyledonous plant.) (Fig.1 (J)).

10) *Elaeagnus*, scale

Disk-shaped with radial lines and serrate margin. Diameter 0.3~0.5 mm. Pale brown or rainbow-colored (These fragments were scales on twigs or leaves of *Elaeagnus* spp. In many cases, they were found as decomposed fragments which were fan-shaped.) (Fig.1 (K)).

11) Unidentified, separate fiber

Elements of fibrovascular bundles decomposed into separate fibers (Fig.1 (L)).

Table 2 shows the mean area of each plant item in hare stomachs. There was a great variation from "other Gramineae epidermis" (501,024 μm^2) to "unidentified separate fiber" (4,820 μm^2). In

Table 2. Mean areas of the plant items in the hare stomachs

Plant item		Mean area (μm^2)
<i>Cryptomeria japonica</i>		171,120
Gramineae	[A]	29,770
	[DE]	62,432
	[DK]	187,900
	Other epidermis	501,024
	Parenchyma	67,850
Fiber bundle		109,524
Dicotyledons	[F]	44,344
	[K]	49,436
	<i>Rubus</i> ?	92,034
	Tree stem	170,280
	Other epidermis	126,569
	<i>Elaeagnus</i> scale	59,092
[PA]		120,975
Unidentified	Epidermis	221,969
	Parenchyma	33,407
	Fiber bundle	174,203
	Separate fiber	4,820

Table 3. Area percentage of the plant items in the hare stomachs

Plant item	Category				
	Total	Male	Female	Preg. female	Non-p. female
	Number of animals				
	20	8	12	6	6
<i>Cryptomeria japonica</i>	13.08	11.82	13.92	20.13	7.72
Gramineae					
[A]	0.46	0.55	0.40	0.44	0.36
[DE]	1.75	1.09	2.19	0.80	3.59
[DK]	2.22	0	3.71	0.44	6.97
Other epidermis	12.94	4.08	18.85	15.57	22.13
Parenchyma	7.88	12.48	4.82	3.39	6.24
Fiber bundle	22.44	28.39	18.47	19.25	17.69
Total	47.70	46.59	48.44	39.89	56.98
Dicotyledons					
[F]	2.56	3.21	2.13	0.38	3.89
[K]	0.78	0	1.30	2.33	0.28
<i>Rubus</i> ?	0.71	1.77	0	0	0
Tree stem	1.06	2.44	0.09	0.10	0.07
Other epidermis	3.33	3.00	3.08	2.03	5.18
<i>Elaeagnus</i> scale	0.24	0.05	0.36	0.72	0
[PA]	4.38	6.21	3.17	5.26	1.07
Total	13.07	16.69	10.65	10.82	10.48
Unidentified					
Epidermis	9.68	9.33	9.90	9.45	10.36
Parenchyma	4.56	5.31	4.06	4.18	3.94
Fiber bundle	2.04	2.38	1.81	2.64	0.97
Separate fiber	9.88	7.88	11.21	12.89	9.54
Total	26.15	24.89	26.99	26.16	24.82

Preg.: pregnant, Non-p.: non-pregnant

total, 21,497 fragments or 893.8 mm² of stomach contents were observed. Their percentages are shown in Table 3 and Figure 2.

The average percentage of each item of all the

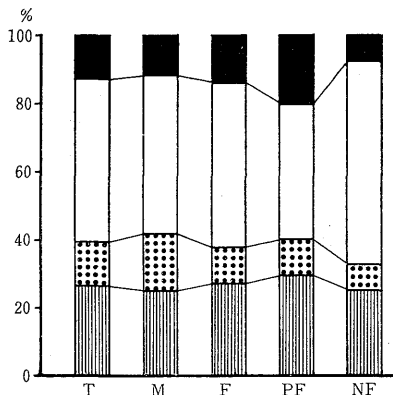


Fig. 2. Stomach contents of the Japanese hares
T: total, M: male, F: female, PF: pregnant female,
NF: non-pregnant female, black bar: *Cryptomeria japonica*, white bar: Gramineae, dotted bar: dicotyledons, lined bar: unidentified

hares was examined. The high percentage of *Cryptomeria japonica* (13.1%) is worthy of notice. It supports the field observations that hares ate a great volume of this plant in this season. In contrast to this, *Chamaecyparis obtusa*, which is known also to be damaged by the hares, was not found. If *C. obtusa* had been eaten by the hares in this study, and if it had escaped from observation, it might have been considered as "unidentified parenchyma" and/or "tree stem epidermis." The percentage of these two items were 4.6% and 1.1%, respectively. Thus the amount of *C. obtusa* must be much smaller, if any, than that of *C. japonica*. The difference of the amounts of the two plants seems to correspond to the variety in the eating habits of the animal. The habits were classified into two types, cutting and barking. In *C. japonica* only the former was observed, but in *C. obtusa* the latter prevailed (3). It is likely that the hares bark the stems of *C. obtusa* not to eat it, but to satisfy some other needs.

Among the other plant items, the large amount of Gramineae (including Cyperaceae whose epidermis resembles that of Gramineae) is notable. This group was the main food of the hares from the quantitative viewpoint, and its contents were not simple. "Other Gramineae epidermis" contained many kinds of Gramineae epidermis, each of which was small in amount. Hares ate many kinds of plants rather than a few definite plants in the case of Gramineae. "Dicotyledons" was also a mixture

of many kinds of plants.

Stomach content percentages for categorized hare groups are shown in Table 3 and Figure 2. The amount of *C. japonica* varied to a degree large enough among the categories to attract attention. Above all, there was a most notable difference between pregnant females and non-pregnant females. Pregnant females ate *C. japonica* in a high percentage (20.1%). On the other hand, non-pregnant females ate it less than males did (7.7% and 11.8%, respectively). It is possible that this difference was caused by the physiological change that pregnancy induced.

Now, further investigations are required for two aspects. First, to establish a more precise formula about sex, pregnancy, and food of the hare, more data are needed. Second, the food habits of the hare are supposed to show great seasonal changes, as well as do those of most other herbivorous animals, but we could not make sure of the changes in this study because all the animals were taken in March. It is necessary to study the food habits of the Japanese hare in other seasons with identical methods.

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