

Behavioural Observations

Case Study of Ant Colony

LS2203 Lab Report
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1 Introduction

1.1 Aim

1. To identify unique individuals in a given ant colony
2. To use scan sampling to quantify proportion of active/inactive individuals
3. To use focal sampling to compare the workload of leaders for tandem runs.

1.2 Theory

An action or series of actions exhibited by an organism in response to a particular environment or a change is called a behaviour. Behavioural observations are crucial for understanding organisms with whom we are unable to communicate verbally since physical gestures are often a reflection of the psychological conduct in absence of common communication link.

The species studied in the report is ***Diacamma indicum*** which is a queenless ant found mainly in India, Sri Lanka and Japan. The ant individuals display many interesting behaviours such as tandem runs, brood transport, etc. The fertile individuals are called **gamergates** which are morphologically indistinguishable from non-fertile individuals.

The ants are unable to leave a chemical trail behind when returning back after finding a new nest or food source, hence the ants in the old nest are unable to directly follow the trail and move to the new nest or food source.

Thus, the ants display an interesting behaviour called **tandem runs**. In tandem runs, few individuals, who know the location of the new nest, become **Leaders** and takes only one ant (which follows the leader and hence is called **Follower**) with it, to the new nest. As relocation of the entire colony is an arduous task, it is not possible for a single leader to relocate every ant in the colony. Hence more than one ant become leaders.

After the leader had successfully relocated the follower, it returns back to the old nest to bring another ant into the new nest. This process continues until the entire colony is relocated.

1.3 Methods

1.3.1 Experimental Setup

The recorded video displayed a part of the path connecting an old ant colony to a new colony. The medium surrounding the path was water.



There was a single entrance to the new colony through which the ants entered the nest. The video recorded the incidents during a particular event of relocation from one colony to another.

1.3.2 Identifying individuals

The video was observed for the entire duration of 41 minutes to identify unique individuals according to the colour coding in their body appendages. The color code was read from head to thorax to abdomen. If in any appendage the color was missing, it was denoted by '-'.

1.3.3 Sampling

For sampling, two methods were used:

- **Focal Sampling** where a particular behaviour (in our case, **tandem run**) was chosen and individuals participating in the behaviour were recorded throughout the entire duration of the video.
- **Scan Sampling** where the collective instantaneous behaviour of every individual was recorded at an interval of 3 minutes until the end of the video.

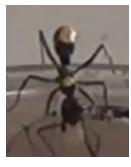
2 Observations

2.1 Identification of Unique Individuals

The entire video was seen minutely to observe the uniquely color coded ant individuals. After observation, **27 unique individuals** were found. The following tables lists these individuals. Since some colours (like blue) were not properly visible due to various reasons, we realise that there might be some ambiguity and the number of unique individuals counted may not be an accurate estimate.

Serial Number	Individual	Colour Code
1		Y-
2		YWW
3		Y-W
4		-WY
5		WY-
6		-Y
7		WWY

2 Observations

Serial Number	Individual	Colour Code
8		-W
9		-R
10		YYY
11		WY-
12		WWW
13		-Y-
14		Y-Y
15		WYW
16		B-B
17		WW-

2 Observations

Serial Number	Individual	Colour Code
18		-W-
19		Y-B
20		-BB
21		-YY
22		WY-
23		YY-
24		BY-
25		-B
26		-YB
27		BYB

2.2 Behaviour Sampling

2.2.1 Proportion of Active Individual using Scan Sampling

We use the technique of scan sampling to determine the actions of individuals at an interval of 3 minutes, for the entire duration of the video. The following table lists the activities of individuals in the 3 minute time intervals.

Scan Number	Timestamp (minute)	Individual	Behaviour	Status	Location
1	0	-	no activity	-	-
2	3	-	no activity	-	-
3	6	-	no activity	-	-
4	9	-	no activity	-	-
5	12	Y-W	Circling/Running	Active	Inside Nest
6	15	WWY	Sitting in one place	Inactive	Inside nest
7	18	WY-	Roaming	Active	Inside nest
8	21	-YW	Entering the nest	Active	Entrance
		-Y-	Entering nest following leader, has egg in mouth	Active	Entrance
		WWY	Standing at one place	Inactive	Far from nest
		-YY	Standing at one place	Inactive	Far from nest
		B-	Circling	Active	Out of nest
9	24	Y-W	Leader, taking follower	Active	Out of nest
		Y-B	Following the leader	Active	Out of nest
		B-	Roaming	Active	Out of nest
10	27	-YW	Coming out of nest	Active	Entrance
		WW-	Sitting	Inactive	Inside nest
11	30	-YW	Restricted movement in one place	Inactive	
		YWW	Running	Active	Far from nest
12	33	-YY	Clinging to the mouth of the nest, no movement	Inactive	Entrance
		—	Moving towards nest	Active	Far from nest
		-W-	Entering nest	Active	Entrance
13	36	YWW	Circling	Active	Inside Nest
		-YW	Entering nest	Active	Entrance
14	39	WWW	Standing	Inactive	Inside Nest
		-W-	Trying to move out, no extensive movement	Inactive	Entrance
		-YW	Trying to move out, no extensive movement	Inactive	Entrance
		WWY	Trying to move in, no extensive movement	Inactive	Entrance
15	41	-Y-	Standing	Inactive	Inside

Further analysis has been done in the section Activity

2.2.2 Using Focal Sampling to analyse the Tandem Runs by Leaders

From analyzing the video, based on their recurring pattern of bringing individuals into the nest and then again venturing out to bring new individuals, we can observe that the following individuals are the leaders:

Leader	Frequency of Tandem Runs
Y-W	10
-WY	7
WWY	6
WWW	5
WY-	1

The plot for the above data and further analysis has been done in section Workload of Leaders.

2.2.3 Special Behaviours observed

- **One ant carrying another**

Males do not participate in runs in general. Thus they have to be mostly carried into the new nest. Sometimes, an injured ant which needs to be translocated to the new nest, is also picked up by a leader and brought to the new nest. One such incident was seen at around 37 minutes 38 seconds where one of the leaders took one follower in its mouth and entered into the nest.



- **Tandem Run with Brood Transport**

Sometimes while performing a run behind the leader into the new nest, a follower picks up an ant egg/pupa. This way, along with the follower, the egg/pupa (which cannot move on its own) is transported into the new nest. 2-3 incidents were seen in the video, at around 21 minutes and 26 minutes.



2 Observations

- **Confused Walker**

The individual -YY appears as follower at around 21 minutes with WWY as leader. Then it gets separated from the leader and roams around the same place far from the nest entrance, apparently confused. Then at about 25 minute, it finally finds the entrance and enters the nest on its own.



(a) With leader



(b) Without leader



(c) Entering the nest
alone

- **Chain of Tandem Runs**

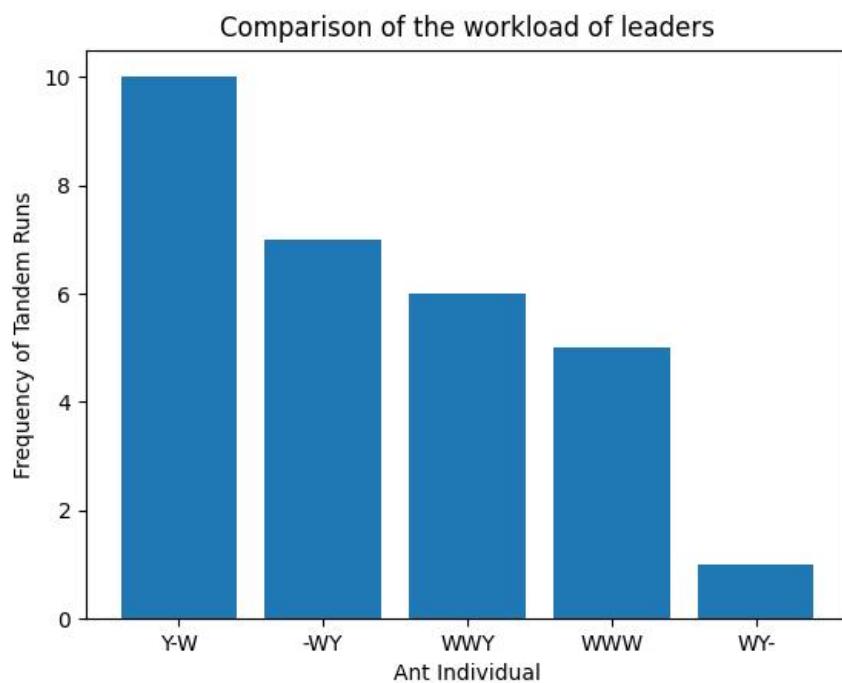
At around 23 minutes, there was a chaotic situation when many ants were advancing together towards the nest. During this period, there was a chain of tandem runs. Many followers exchanged their leaders during this period. They initially came with different leaders but after interaction during the chaos, they went into the nest following other leaders.



3 Results

3.1 Workload of Leaders

We plotted the number of tandem runs performed by each leader vs. the frequency of runs into a bar plot.

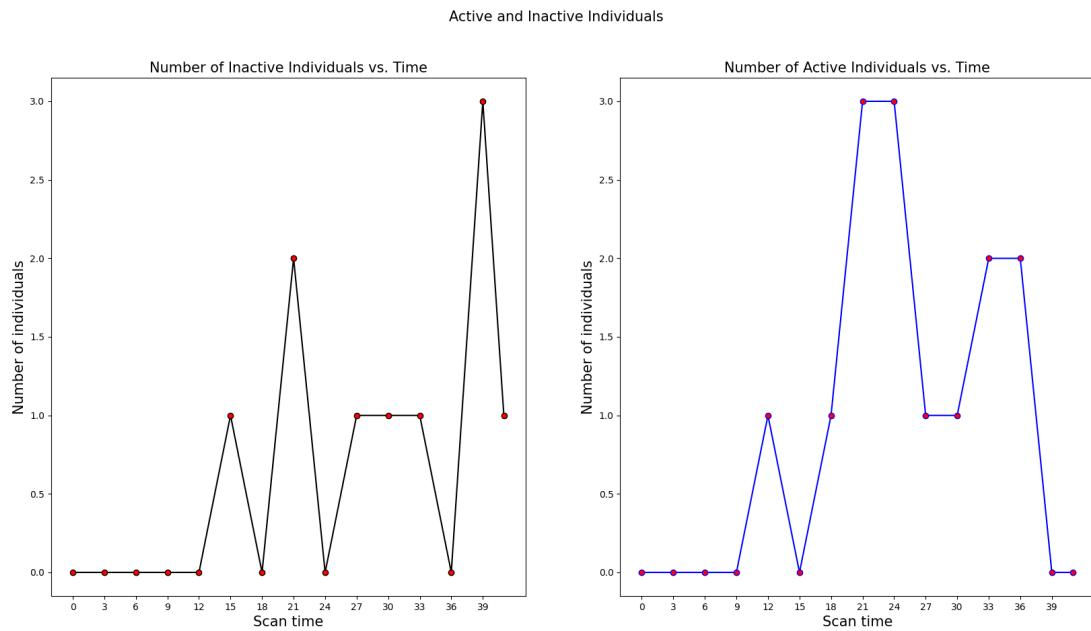


From the plot we can see that the individual Y-W performed the highest number of tandem runs (10) and the least was performed by WY- (1) during the entire length of the video. Thus, the **efficiency of Y-W as a leader is the most**.

3.2 Activity around the entrance

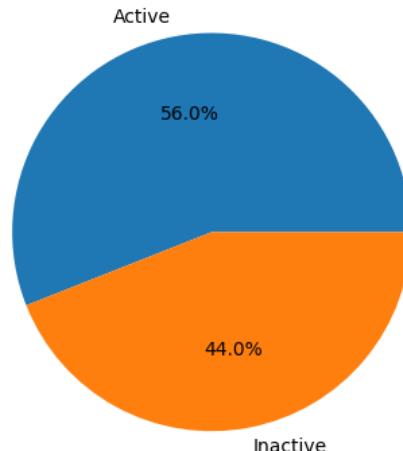
From the result of the scan sampling, we determined the number of active individuals in the specific time intervals during which we performed the scans. The following graph has been plotted which shows the number of active and inactive individuals with time interval. We quantify the activity of the ant colony by the number of active individuals.

3 Results



Number of Active and Inactive individuals

We can observe that during the initial period, there was lesser activity. The activity peaked in the middle (during 18 min, 21 min and 24 min) and again it started decreasing.



Pie Chart showing the proportion of active vs inactive individuals

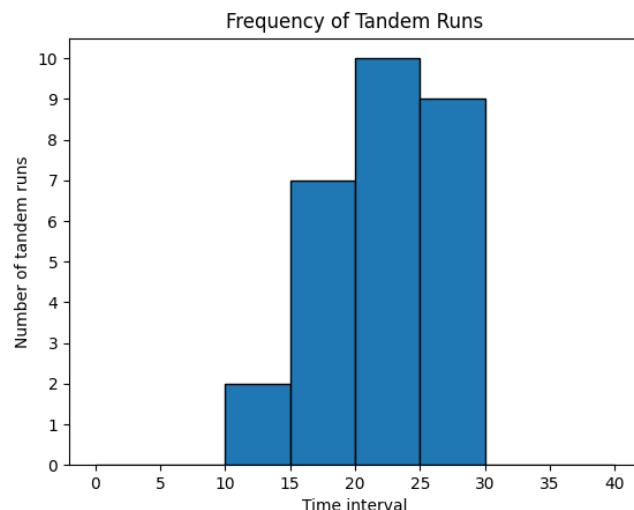
3.3 Frequency of Tandem Runs

We quantified the total number of tandem runs with time intervals of 5 minutes. The following data table was obtained.

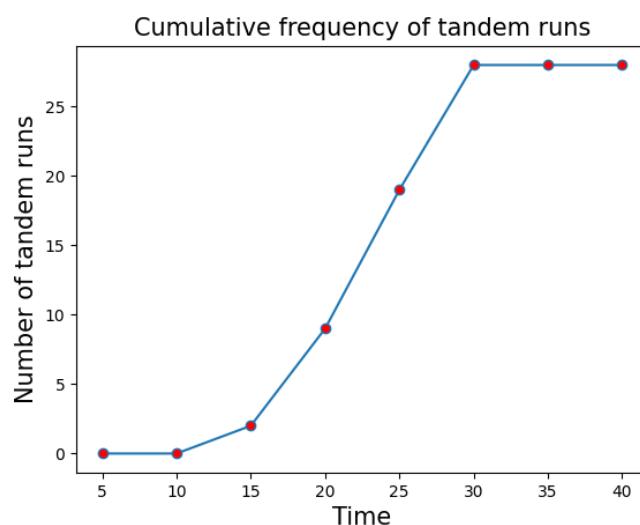
3 Results

Time Range	Number of Tandem Runs
0-5	0
5-10	0
10-15	2
15-20	7
20-25	10
25-30	9
30-35	0
35-40	0

The following histogram is based on the above table. It shows that the number of tandem runs peak during 20-25 minutes, indicating that most of the leader actively participated in relocation during that time.



Initially the tandem run frequency was less as the leaders needed to get acquainted with the new nest and slowly bring the followers. The final frequency is also less because all the relocation has been completed by then.



The result is also evident from the above plot of cumulative frequency of tandem runs. The total number of tandem runs till a particular time increases in the middle and then stagnates after 30 minutes. This signifies that the relocation of the colony has been successfully completed.

4 Limitations

The results obtained from the video might be erroneous as the experiment posed many limitations.

1. The colouring of the ants was difficult to understand. It was difficult to ascertain the colour code of some ants as they were moving very fast.

Moreover, the angle was not always perfect to understand the coloring of an individual ant and the reflection of light on the ant's body might give an impression of white colour which is not present.

The blue colour was particularly difficult to identify since the colour was almost indistinguishable from the actual black colour of the ant body.

2. As told by ma'am, the ants regularly clean their body using the bristles in their limbs and thus the paint might chip off which could lead to ambiguity in detection of the ants uniquely.

In few frames in the video, the colouring seemed to be incomplete in one part and the above mentioned reason can be a possible explanation.

3. At 23 minutes, it was very difficult to understand the incidents occurring as many ants were there in the frame, posing a chaotic situation. During this period, there were a lot of exchange of leaders by the followers due to which it became difficult to identify successful tandem runs.

4. It was very difficult to label an individual as active/inactive and depends on the subjectivity of the observer seeing the video. Hence, the number of active/inactive individuals are only a rough estimate.

5 Conclusions

The video of the particular incident of relocation of the ant colony was seen and notes were taken along the length of the video (Ad libitum).

Then, observations were done for the specific tasks required. From the data of these observations, appropriate graphs were plotted which provided a quantitative estimate of the parameters observed. From the analysis of the plots, we can conclude the following things:

- **Number of Individuals**

There are atleast **27 unique ant individuals**, with different color codes in the colony.

- **Leaders**

There are **5 leaders** viz. Y-W, -WY, WYW, WWW, WY-. Among these leaders, **Y-W is the most efficient** and **WY- is the least**.

- **Frequency of tandem runs**

Most of the tandem runs were done in the middle of the video, the highest being **10** during the interval between 20 minutes and 25 minutes. After 30 minutes, the number of tandem runs decreased as by then relocation has been completed.

- **Activity around entrance**

There were more number of active individuals than inactive.

Supplementary

4:11 → red abdomen

abs - 0°

4:56 → silver abdomen

6:22 → silver/white WWY

8:05 → YWW (7) 6cm (5) 11°

9:55 → W-Y ecology (7) 6cm - 5.83 mm/s

12:45 → (W-Y) → Y-B
B abd.
T 8mm/s

11:30 to 2pm (7)
11:11 6cm 11:44 7

12:53 → YWB
B abd. 7cm 5.5

12:32 finally 2pm
most prob silver 6cm/s

12:50 → 13:10 7cm

13:23 → W-Y 2pm 2.5 cm/s 11° 6.5 cm/s

13:41 → (W-Y) → YWW 7cm 6.5 cm/s But 11°
13:55 7cm

14:30 → YWB 2pm

11° 7cm

B-Y 3 2pm → 6cm 6.5 cm/s
Y-W " "

14:41 → unknown colouration 11° 6.5 cm/s

15:21 6cm (5) 11°

(-WY)

{ 15:50 → (W-Y) → Y- 11° 6.5 cm/s → 7cm 6.5 cm/s
16:01 → (YW) → YW 7cm 6.5 cm/s

YW -

16:08 → Y- vs. -WY 6.5 cm/s 11°

16:16 → YW 6.5 cm/s

16:19 → YW - 2pm, YWW 2pm, 6.5 cm/s

18:41 → (WY)

5.5 cm/s 7 cm/s hcA

$\frac{32 \times 10^17}{5.5 \times 10^17}$

16:37 → W-Y 7451 nm

16:57 → ~~WYW~~ \rightarrow ~~yellow~~
color yellow

SM25 W-Y 3

27.06.2023 but 43° 720nm 751nm

17:10 → W-Y , B-Y 740 nm 751 nm but 43° 720 nm 751 nm

17:16 → W-Y \rightarrow W-W 740 nm 43° 720 nm 751 nm

17:24 → -Y W 7451 nm 751 nm, 720 nm - 751 nm 720 nm

17:31 → $\text{W-Y} \rightarrow \text{WWW}$ 740 nm 751 nm

17:40 → WWW 740 nm 751 nm

17:38 → ~~YW~~ YWW 7451 nm

17:40 → W-Y 7451 nm

17:43 → Y-W //

18:14 → -Y W 7451 nm

→ $\text{YW} \rightarrow \text{WY}$ 740 nm 751 nm finally

$\text{YW} \rightarrow \text{Y-Y}$ 740 nm 751 nm

740 nm 751 nm 720 nm 43°

18:58

18:29 → Y-W 7451 nm, 720 nm 751 nm

18:27 → -Y W 740 nm 751 nm

18:32 → WWW 7451 nm

18:36 → YWW 7451 nm

18:41 → YWW 7451 nm, 720 nm 751 nm

18:41 → WY 740 nm

18:47 → WWW 740 nm 751 nm,

$$6 \times 10^{-39} \text{ Js} \cdot \text{s} \cdot 3 \times 10^{10} \text{ cm} \cdot 10 \text{ cm}$$

20:54 - unknown $\xrightarrow{\text{WY}} \dots$ 21:03 ৩০৮ল

21:02 - $\text{WY} \xrightarrow{\alpha} \text{Y - } \text{WY}$

WWY \rightarrow WY আসল হল
21:19 \rightarrow ২৫৮ গেল

21:12 \rightarrow ২১:19 \rightarrow ২৫৮ গেল

21:17 \rightarrow WY ৩০৮ল.

21:20 \rightarrow $\text{Y - W} \rightarrow \text{WYW}$ ২০ স্লায় পুকুর

21:22 \rightarrow WWY ২৫৮ পুকুর

21:30

21:32 \rightarrow Y-W ২৫৮ ল

unknown
চাক স্লায়
 α

21:55 - $(\text{W}, \text{WW}) \rightarrow \text{WW-}$ ৩০৮ল

22:10 \rightarrow WWW ২৫৮ ল

22:25 \rightarrow (WWY) \rightarrow - - B \rightarrow ৩০৮ল

22:32 \rightarrow (Y-W) \rightarrow - - WW ২৫৮ পুকুর \rightarrow দ্রুত পুকুর

22:38 \rightarrow $\text{WY} \rightarrow$?? স্লায় গেল

22:38 \rightarrow WWY ২৫৮ পুকুর

22:46 \rightarrow Y-W ২৫৮ পুকুর

22:56 \rightarrow ~~WWY~~ \rightarrow - - WY

23:14 \rightarrow (Y-W) \rightarrow - - B ৩০৮ল

23:19 \rightarrow Y-W একাধি ৩০৮ল গেল।

দ্রুত পুকুর

initial 23 min entry class
7 ant
প্রক্রিয়াজন

23:22 → WWW ৭৫৮ লি

23:24 → Y-W "

23:44 → WWY → YWB ৭৫৮ লি

23:39 → WY ৭৫৮ লি

23:42 → WW ৭৫৮ লি

23:48 → -WY → W-W ৰিয়েল চুক্কা

23:51 → WWY ৭৫৮ লি
unknown estow ৭৫৮ লি

23:57 → -WY ৭৫৮ লি

24:04 ~~23:57~~ → Y-W → Y-B ০১৮২-

24:09 → -~~WY~~ YW ৰিয়েল

24:13 → Y-W ৭৫৮ লি

24:20 → WW- ~~বিল~~ চুক্কা
unknown ~~বিল~~

24:32 → WWW → (রাগি) ৰিয়েল চুক্কা

24:40 → WW- ৭৫৮ লি

24:41 → WWW ৭৫৮ লি

24:55 → unknown ৭৫৮ লি

| -YY ৭৫৮ লি 24:52
| - চুক্কা শুণিয়ে

25:01 → WWY → -R ৰিয়েল চুক্কা

25:14 → WWY ৭৫৮ লি

~~25:18~~ 25:25 → Y-B ৭৫৮ লি

25:33 → WWW → চুক্কা

25:38 → WW- ~~বিল~~

25:42 → WWW ৭৫৮ লি

25:54 → Y-W → W-Y ৰিয়েল চুক্কা

~~25:~~ 26:00 → WWY → (B-B) ৭৫৮ লি

26:08 → Y-W ৰিয়েল চুক্কা

26:59 → Y-W TANZ

26:12 → WWY " "

26:19 → -WY → WYY 紅腹鷦鷯

26:29 → (WWY) → Y.W -

26:
56 → -W → -W-TANZ

27:32 → (-WY) → cunha

27:49 → (WWW) → BY -

28:17 → (WY) - → YWW TANZ

~~38:~~ 紅腹

38:37 → 紅腹 鳥類
470 紅腹鷦鷯

next A

18:07 18:25

tandem
雌雄 (A) 順序交配

27:51 27:52

broad
Transport.

Y-W → 17:31, 12:45, 13:41, 15:50, 17:10, 24:04, 25:54, 22:32, 21:20, 26:56

-WY → 16:01, 17:16, 18:14, 23:48, 21:02, 26:19, 27:32

WWY → 23:44, 26:00, 22:25, 25:01, 16:57, 26:29

~~紅腹~~

WWW → 24:32, 25:33, 21:55, 27:49

WY - → 28:17

Individuals.

✓ Y- - 16:08 BY - → 27:49
✓ YWW 8:05
✓ Y-W 9:55 - R → 25:01
✓ B-Y 12:45

YWY - ??
✓ -WY 16:01
✓ WY- 16:01
✓ --Y 16:14 (check)
✓ WWW 17:38
✓ Y-B 17:10
✓ -W 17:16

✓ WY- 18:14 (check)
✓ WWW 18:32

x W-Y 17:43

x -WY 18:14

✓ Y-Y 18:14

-YW 18:41

✓ -Y- 21:02

✓ WYW → 21:20

✓ Y-W → 21:20
✓ -YY → 21:43

✓ ~~WYW~~ YY → 23:19

✓ WWW → 23:42

✓ Y-B → 25:25

✓ B-B → 26:00