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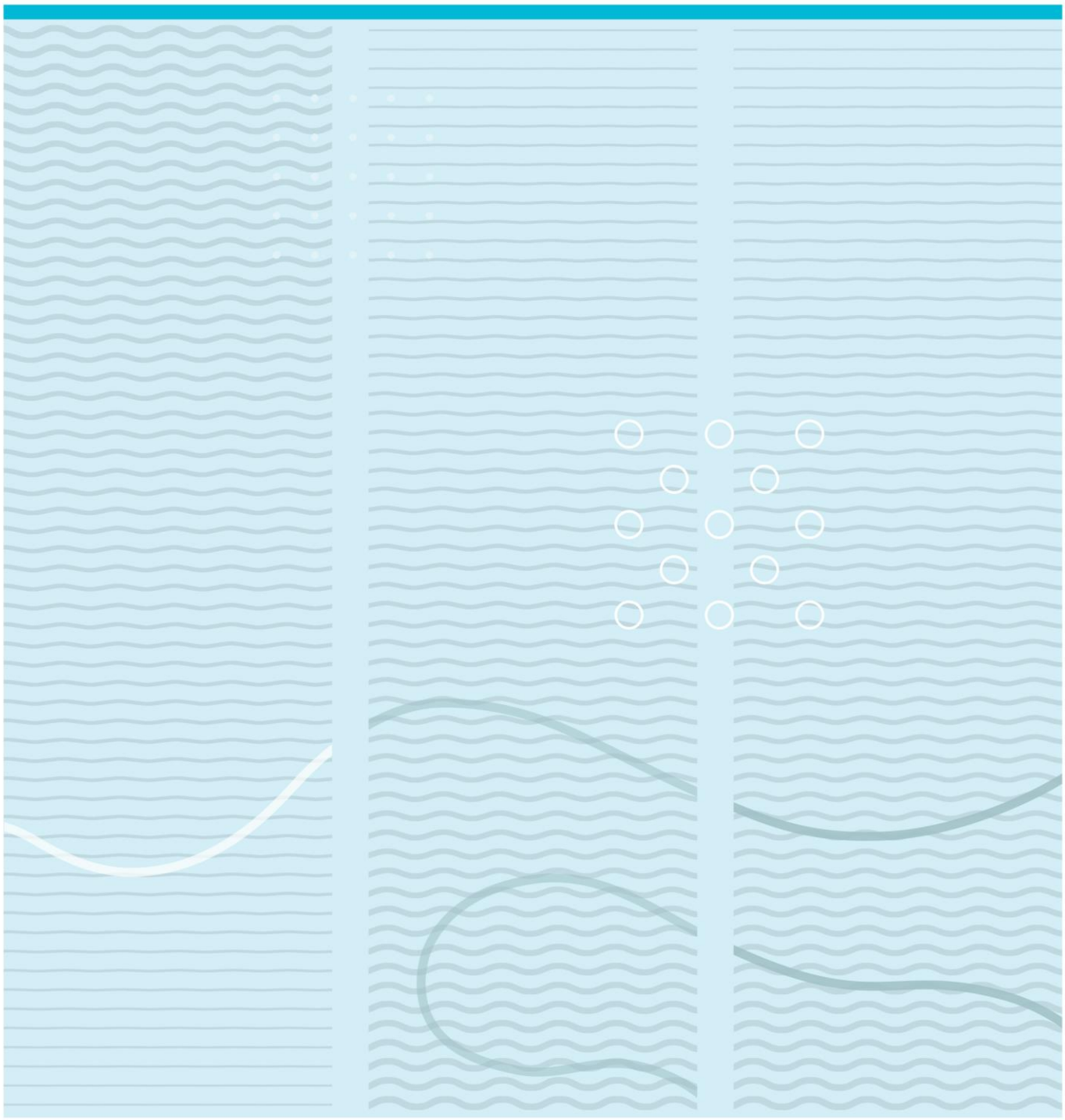
Brown trout Personality: Boldness, Explorative and Risk taking behaviours



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This thesis is worth 60 study points

Summary

Animal personalities are well defined as expression of individual behavioural syndromes that are stable over time and context. Personalities are interesting and equally important to study the individual differences that prevail in them. The study was done with an interest and eagerness to know what kind of personality brown trout (*Salmo trutta*) possesses. The study was done in Bø fish hatchery. The number of fish used in this study was 100 of total length 6cm and one summer old brown trout 0+ years. Boldness, explorative and risk taking behaviour were investigated in the studies. Based on these results, brown trout individuals were categorized into shy, intermediate and bold respectively. The study focuses on the behavioural responses of individuals exposed to the novel object. An experimental tank (418 L*424 W * 144 H mm) divided into acclimation area and a novel object in the experimental area by plywood door was used in the experiment. The novel object used in the experiment was glass jar (80 W* 130 H mm) with natural stones. The fish were kept in the acclimation area for 5 minutes before opening the door to explore, experimental area where the novel object was placed. The responses were observed as movements in fish. The time taken to explore and reach the novel object by fish was noted. To keep track of fish movement, the tank was covered with a translucent plexiglass (500 L*475 W mm) divided into a grid of 64 (5*5) cm squares. Those fish which managed to reach the novel object within a distance of 5 cm at specified time of 120 seconds were categorized as bold, those taking 300 seconds as intermediate and those taking more than 300 seconds or not approaching the novel object at all as shy. In the first experiment, 84 shy, 13 intermediate and three bold were found. The result found in the second experiment was more or less the same with 70 shy individuals, 12 intermediate and eight bold. The number of shy individuals was found high in both the experiments. Plasticity and propensity to take risk was found low in the studied individuals. Compared to previous studies where fish from hatchery were supposed to be bold, the results from my study showed high number of shy individuals. Also the exploring and risk taking behaviour was found less in my study as compared to other studies, where trout were found bold.

Abstract

Personality helps in finding the underlying behavioural traits in individuals. As there has been not much study on the personality of fish, brown trout was taken as interesting study material to focus on behavioural responses in terms of exploring, response to novelty and being bold and adaptable. 100 brown trout (*Salmo trutta*) individuals were used in this study. The total length of the fish was 6 cm and was one summer old 0+ years. This study also indicates that most of the brown trout individuals were shy in both the experiments. The result showed 80 % shy, 12.5% intermediate and 7.5 % bold.

In hatchery stream tank, an experimental tank (418 L *424 W *144 H) divided into acclimation area, and a novel object in the experimental area by plywood door was used in the experiment. The novel object used in the experiment was glass jar (80 W* 130 H mm) with natural stones. The fish were kept in the acclimation area for 5 minutes before opening the door to the experimental area, where the novel object was placed. To keep track of fish movement, the tank was covered with a translucent plexiglass (500 L*475 W mm) divided into a grid of 64 (5 *5) cm squares. The fish were categorized on the basis of time taken by them to reach the novel object within 5 cm. Those fishes that took 120 seconds to reach the novel object within 5 cm was categorized bold, those fish which took 300 seconds as intermediate and those fish which took more than 300 seconds or did not approach novel object as shy. To test the consistency of the results, or if trout would learn, the experiments were repeated. Comparatively, the result from the first and second experiment revealed the same result with high numbers of shy fish, and with very few bold fishes. Almost 50 % of the studied individuals were trying to be hideous and quiet; moreover passive behaviour was observed in them. The overall personality of fish was found to be shy and they had low ability to learn and adapt. Compared to other studies where fish from hatchery are supposed to be bold, my study revealed most of them as shy. The results from my study can be used as a basis for further research on the personality of brown trout.

Key words: Brown trout, Bø fish hatchery, Bold, Shy, Intermediate, Personality, Plasticity, Behaviour, Novel object.

Table of Contents

1 Introduction 7

1.1 Objectives and hypothesis 10

1.2 Limitation of the study 10

2 Methods 11

2.1 Experimental design 11

2.2 Experimental setup 12

2.2.1 Experimental Fish 12

2.2.2 Environmental condition 12

2.3 Protocol 12

2.4 Data analysis 14

2.5 Study Area Map 16

3 Result 17

3.1 Behavioural consistency across two different novel objects 17

3.2 Time factor 18

3.3 Latency period before approaching novel object 19

3.4 Boldness 20

3.5 Novel Object 20

3.6 Passive behaviour 21

3.7 Distance travelled 23

4 Discussion 26

5 Conclusion and recommendations 29

Foreword

I feel privileged to be accompanied with practical and moral support of many people during my study at both personal and professional levels and now I have a pleasant opportunity to express my appreciation.

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1 Introduction

The widely distributed and both economically and culturally important brown trout prefer habitat with shelter and cover, which suggest brown trout is generally shy and this behaviour is to hide from the enemies. Often preferable habitat of brown trout is the vegetation or close to the substratum (Gatz Jr et al., 1987).

Personality difference is very common throughout the animal kingdom. “Difference in the personality matters both in ecological and evolutionary processes” (Wolf and Weissing, 2012:452) because of its role in plasticity and adaptation. It also relates to intra-specific variation and other aspects of life history. Variation in the behavior is the continuous process existing in human and some other species (Wilson et al., 1994:1). Each individual has their own behavioural differences which continues throughout their lifetime (Réale et al., 2007).

Behavioural responses may be used to characterize how each and every individual are (Sneddon, 2003) in terms of for example being shy or bold in the new environment, especially how they cope when brought to completely new surroundings. Each individual may differ in their characteristics; some are aggressive, explorative, and bold whereas the other may be quiet, inactive and shy.

Variations in behavioural responses of the individuals could also depend on their body size. This is seen in fish, in which social dominance tends to depend on their size. For example, the smaller Poeciliid *Brachyraphis episcopi* deviates away from group whereas the larger females tends to be in its own specified area (Brown and Braithwaite, 2004) indicating that the younger ones are more risk taking.

Behaviour may also change morphologically and genetically. Some responses may be more opportunistic, flexible and immediate and reflecting phenotypic plasticity with context-dependent responses in a competitive or variable environment (Wilson, 1998). There also occurs a difference in developmental plasticity between the shy or bold phenotypes, which explains of the fitness in the different kinds of environment and also the developmental variation (Sinn et al., 2008). According to Thomson et al. (2012) bold fish were found plastic and exhibited greater behavioural plasticity in their response to the novelty than the shy fish.

The challenge to risk in terms of being bold enough to acclimatize in the new situation without hesitation to approach any kind of obstacles is the qualities of being bold and equally adaptive (McKenzie and Batterham, 1995). Eagerness and expressiveness are the foremost qualities of a bold individual. Boldness also helps individuals to survive and become adaptive in certain conditions. For example, the aggressive and explorative behaviour in bolder animals may help them to survive where there is less availability of food and habitat (Dingemanse et al., 2004).

The bolder animals also tend to be more flexible, and may opportunistically adapt themselves according to how beneficial the different strategies are under the current prevailing conditions. They may in turn adaptively switch their responses from shy to bold (Sih et al., 2004, Koolhaas et al., 1999). Adaptation also requires phenotypic plasticity (DeWitt et al., 1998). Frost et al. (2007) in their study on Plasticity in animal personality traits found that prior experience may alter the degree of boldness in fish (Conrad et al., 2011),whereas other individuals may not change e.g. shy rainbow trout (*Oncorhynchus mykiss*) that were found to remain less active and shy (Thomson et al., 2012).

Different individuals have different qualities that define them; some are very responsive and quick learners whereas some slow learners. Adriaenssens and Johnsson (2011) found that the hatchery reared brown trout were more successful feeders and fast learners than the wild, but regarding the repetition of exploratory behaviour, wild ones were more consistent in their strategies.

According to Sundström et al. (2004), study on two weeks old brown trout of wild and sea ranched origin found that hatchery selection promotes boldness in young old brown trout. The boldness test done with novel object tack and with food brine shrimp showed that the fish of sea - ranched origin were bolder in average than the fish of wild origin. Also, the boldness towards the predators is high in hatchery selected fish, which increases along with their age. According to Wilson et al. (1994), the shy–bold continuum explains the reaction of an individual to novel object and challenging situation.

"A behavioural syndrome is a correlation between behaviours in different contexts" (Bell and Stamps, 2004:1339). They argue that behavioural syndromes may not limit

behavioural plasticity, rather depending on certain ecological and developmental circumstances, different personalities like boldness or shyness might be favoured.

With some limiting factors in the current niche, the bold individuals possess the advantage of being adaptive due to the possession of explorative characteristics. The bold species individuals generally possess some descriptive characteristics such as eagerness, explorative. In a prevailing competitive world, the bold individuals tend to be more adaptive than the shy ones. For example, in case of the deficiency of food and habitat, the bolder individuals tend to survive due to its explorative and risk taking behaviour (Dingemanse et al., 2004).

Bold individuals triumph over fear and endeavour more risk taking behaviour, whereas the shy one lacks the confidence of being more interactive (Sneddon, 2003, Sih et al., 2004, Thomson et al., 2012). This behaviour can however change with time. Some factors also prevail in upcoming stages of life time specially related with the number, growth and fertility. Boldness is also associated to the consumption of food, productivity and other traits (Biro and Stamps, 2008).

Domesticated individual when exposed to the wild environment may be more vulnerable than their wild countrespecifics, and lack the confidence required to rapidly adapt to the new environment. A study on Atlantic salmon revealed that the risk taking behaviour was more in individuals reared in hatcheries without predators than for the wild (Roberts et al., 2011). Fish reared in a hatchery environment generally are less able to adapt to natural habitats, because they are not used to with surviving in the environment with predators.

However, some variation among the individuals also confers adaptive capabilities and resilience to the population. The qualities present in the individuals are responsible for its survival (Dingemanse et al., 2004, Thomson et al., 2012).

Males are found to be more aggressive than females but may not be dominant in all the tasks in salmonid fish (Johnsson and Akerman, 1998, Johnsson et al., 2001). “The adult male brown trout are generally more aggressive and vigorous than females during spawning and the aggressiveness may be genetically correlated with adult aggression in fish” (Johnsson et al., 2001:596).

A factor stress also has an impact on the individual either to overcome it and be adaptive or vice versa. A response to the stimuli in order to cope with the unknown

situation is an example for adaptation to the environment (Koolhaas et al., 1999, Thomson et al., 2011).

The present study aimed to

Find out what kind of behavioural responses that brown trout in general tend to possess along the bold –shy axis.

Find whether these behavioural responses were consistent or different among individual and

Find out if trout possess some plasticity across time in their behavioural responses.

1.1 Objectives and hypothesis

The objectives of the study mainly focus on the individuals responses.

1. If there is such a thing as trout personalities, ie. Consistency in individual decision making over time apparently not motivated by environmental information.
2. If there is an element of chance in instrumental behaviours, ie. Lack of consistency in decision making over time apparently not motivated by environmental information, and not related to individuals.

1.2 Limitation of the study

1. The camera trapping techniques was not used in the experiment to observe the movements of the fish.
2. The field work comprised of month October 2014 only other months were not included for comparative studies.
3. The number of experimental fish reduced from100 in the first experiment to 90 in the second experiment due to death of some fish and some was lost by jump due to uncovering of the experimental tank.
4. The total distance of the fish were calculated by the number of squares moved a rough estimate which was equals to 5 cm.

2 Methods

The experiments were conducted with permission from and at the Bø fish hatchery. The study area was located in Bø municipality, Telemark, Norway. The hatchery had both ground water and river supply, which they can mix in the hatchery itself to maintain required water temperature. The work was done in October 2014 with one original and one repeated series of the same experiments and on the same individuals. The total number of brown trout used in the experiments was n=100 which were randomly chosen from a large holding tank with about 3000 individuals. In the first part of the experiment, the number of brown trout was n=100. In the second experimental series with the same fish, the number was reduced to n=90 because the remaining fish jumped out of the holding tanks due to absence of cover for three days. The movements and behaviour of each experimental fish were the primary response variable, and were observed carefully and noted.

2.1 Experimental design

The total experiment unit is (418 L *424 W* 144 H mm) with filter holes at the bottom. A 6mm transparent plexiglass cover the experimental tank during each experiment, marked with a 50*50 mm grid covering the entire experimental unit (the actual measurement of the plexiglass cover was (500 L*475 W mm). A total of 64 divisions on the plexiglass are made to track the fish movements in the square. The tank is further divided into (16 and 48) squares, out of which 16 squares cover the acclimation area and the remaining 48 squares cover the larger experimental area in the tank. A plywood door separates 100mm wide and 400mm long acclimatization area from the 300mm wide and 400mm long remaining experimental area. The tank has acclimation area to make sure the fish is not stressed, and the experimental area where the experiment can be proceed further with the novel object. The plywood wall was 14 mm thick, 161mm high and 420 mm wide, the half of which was a door that could be removed to open up to the experimental area (opening 210 mm).The fish is kept in acclimation area for five minutes before opening the experimental area.

2.2 Experimental setup

In the experiment, a flow through system was used with the experimental tank (418 L*424W*144 H mm) with filter holes at the bottom (Fig.2-1). At the same time, alternate and identical tanks were used. The flowing tap water provided water continuously in the experiment and with a drain at the end of the tank. Water depth was kept constant at 7.2 cm. Water flow was 1 L/s. To avoid any disturbance from the observer to the experiment fish, long black plastic curtains provided with narrow observation openings (L=10cm, W=2cm) were placed around the experimental area.

2.2.1 Experimental Fish

The fish studied was first generation hatchery juveniles originating from wild brood stock collected from the previous fall from the nearby Lifjell Mountain (Holmen Lake) population. The experimental fish were one summer old, and hatched in April i.e. 0+ years brown trout.

2.2.2 Environmental condition

The environmental conditions were always maintained by the Bø fish hatchery staff and at a constant regime. Each day, the experimental fish was fed once and at the same time. The mean temperature of the water during the experimental month October 2014 was 8.1 C and varied only 0.5 C. Light intensity was 19-23 lux during the 12 light hours in the hatchery.

2.3 Protocol

Each fish was captured carefully from the large holding tank with the help of dip net and placed in the acclimation area of the experimental tank. The fish was allowed to rest for 5 minutes with the plywood door closed. The movements of the fish were observed carefully and the time taken and visited grid squares will be noted. After 5 min the plywood door was opened and the fish was allowed for free movement in the open environment for 20 minutes and the experiment was continued with glass jar as novel object in the first experiment. Any further movements were tracked carefully and each grid cell visited was successively noted. The response variables, time and movement were observed and calculated within the 20 minutes, in the first part of the experiment. After the completion of the first experiment with the 100 individual trout, they were categorized and put into their respective tanks as shy, intermediate and bold

respectively. A repeated experiment was carried out with the same individuals that were formerly categorized with novel object glass jar filled with natural stones to see if any changes occur. The changes could be like if any shy transformed into bold or intermediate or any intermediate change to shy or bold and vice versa.

Movements were the response variable observed after the acclimation in terms of exploring and novelty response by the fish. The fish was observed at distance of 5 cm on their willingness to approach the novel object and classified accordingly.

There are no standardized categories or procedures used in this study. Based on previous work, the novel object test for assessing boldness and risk taking behaviour were previously done in other studies for rainbow trout (*Oncorhynchus mykiss)*. For example, those approaching the novel object at 5cm within 180s as bold and those approaching the novel object at 5cm within 300s as shy (Thomson et al., 2011, Thomson et al., 2012). Fish were classified as those which came within 5 cm of the novel object as bold and those which managed the novel object within 10 cm as intermediate and fish that did not reach the novel object as shy (Frost et al., 2007). However, this study has set the hypothesis categories accordingly.

The classification of individuals into bold, intermediate and shy was based on the following behavioural characteristics:

Bold: Individuals which approached the novel object at distance of 5 cm within the specified time 120 seconds.

Intermediate: Individuals which approached the novel object at distance of 5 cm within the specified time 300 seconds.

Shy: Individuals which approach the novel object at distance of 5 cm after 300 seconds or did not approach at all.

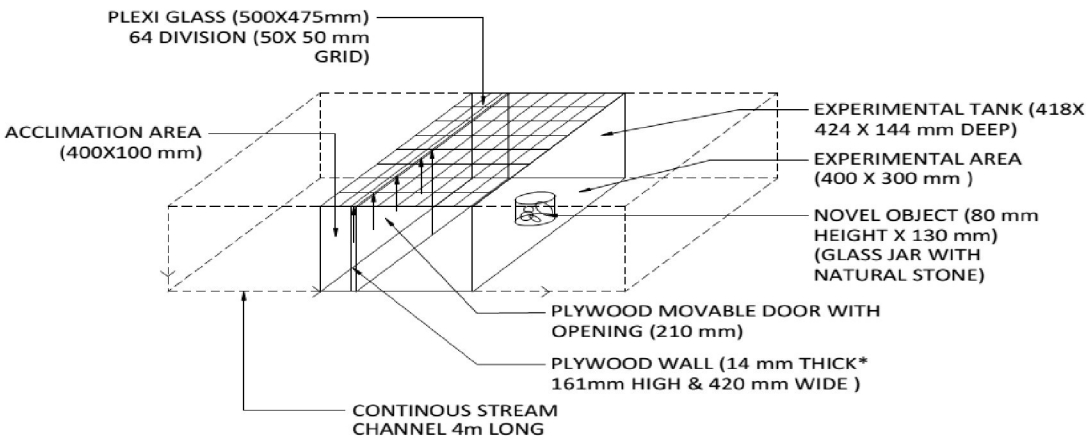

Figure 2-1Experimental unit design (acclimation area and experimental area divided by plywood door)

2.4 Data analysis

The programs used for the calculations of the data were Excel and R. All the histograms were made by using Excel (Microsoft office Excel 2007). All the Statistical calculations were done by using R (R*64 3.0.1) with the Rcmdr package. The statistical Pearson's chi square (χ^2) test was performed to the experimental data. Both the data from the first and the second experiment was used for the statistical analysis. The data was categorized into three types shy, intermediate and bold respectively. Null hypothesis and alternative hypothesis was set accordingly for the test of association and homogeneity to verify the obtained data. The chi square test of association was performed to see if there is importance of the factors, the types and number from the observed data. Similarly, the test of homogeneity was performed to test the homogeneity in the distribution. Two sample t- test were also performed to find out the significance differences in the mean of the data.

Each individual were categorized as shy, intermediate and bold respectively on the basis of experiment done with novel object test (a glass jar filled with natural stones) within a distance of 5 cm.

Movements in fish were calculated by locating the number of squares travelled by the fish where each square was equal to 5 cm.

The total distance covered was calculated by the total number of squares moved by the fish multiplied by 5 cm.

The latency period was calculated computing time taken by fish to change its position to move out from acclimation area towards the experimental area.

The latency period before approaching the novel object was calculated as the time taken by the fish to approach novel object first time within specified time in the experiment.

The latency period to reach the novel object was calculated as the time taken by the fish to approach novel object within specified time in the experiment.

The passive behaviour of fish which includes staying still, moving their body and fins as assumption was taken into account for the calculation of passive behaviour in fish.

The total passive behaviour was calculated as an aggregate of the passive behaviour shown by fish in the first 20 minutes, and passive behaviour in the other half of the experiment with the novel object.

2.5 Study Area Map

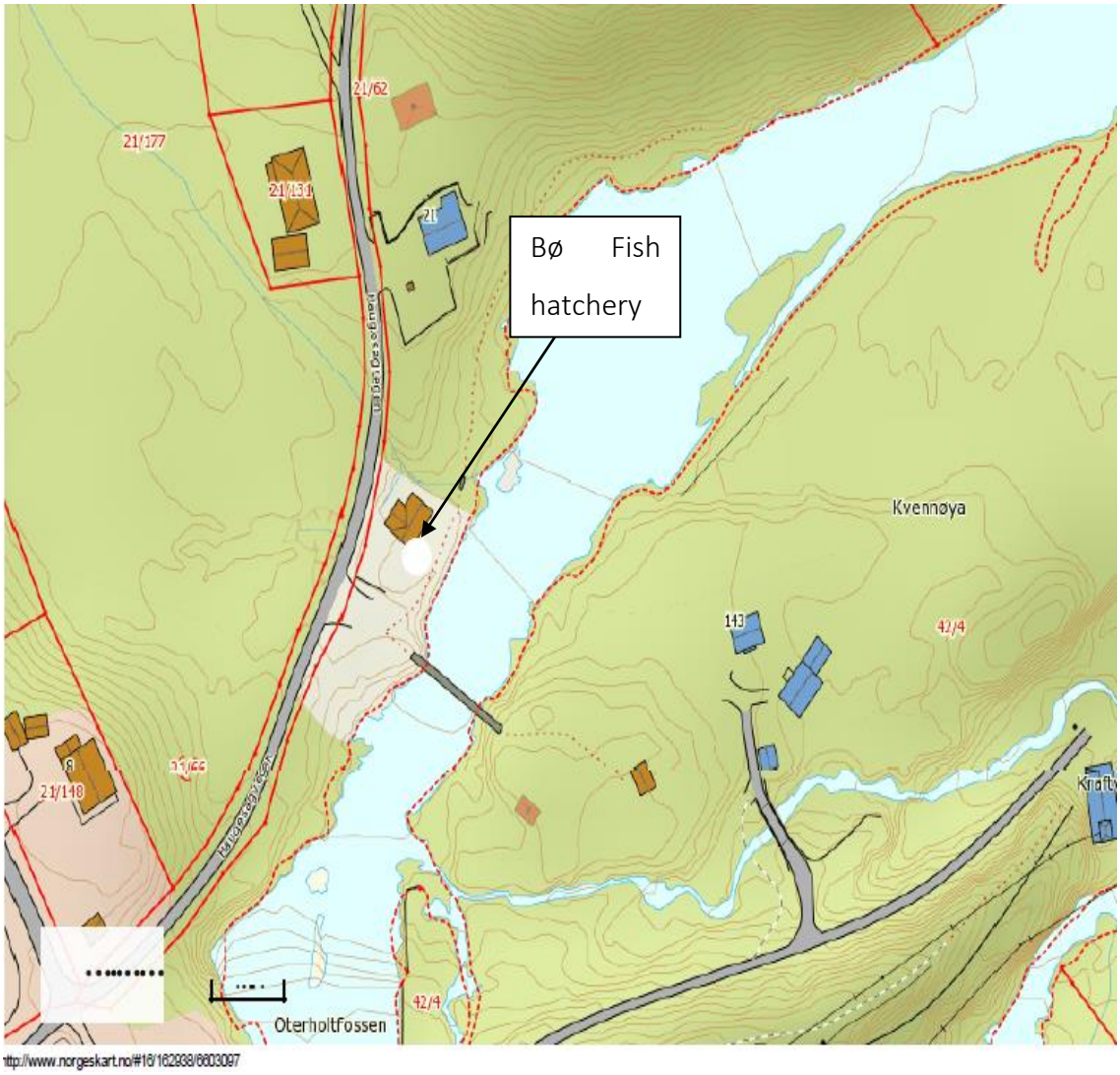

Figure 2-2 Map showing the study area Bø fish hatchery

3 Result

Of the 100 brown trout individuals, most of them were found to be shy. In the first series of the experiments with the transparent glass jar as the novel object, the number of trout which were classified as shy based on their behavioural responses, was found to be 84, followed by 13 individuals classified as intermediate, and finally three individuals as bold, clearly not a random distribution. Pearson chi-square test, of association χ^2=2.4238, p=0.2976 (Fig.3-1).

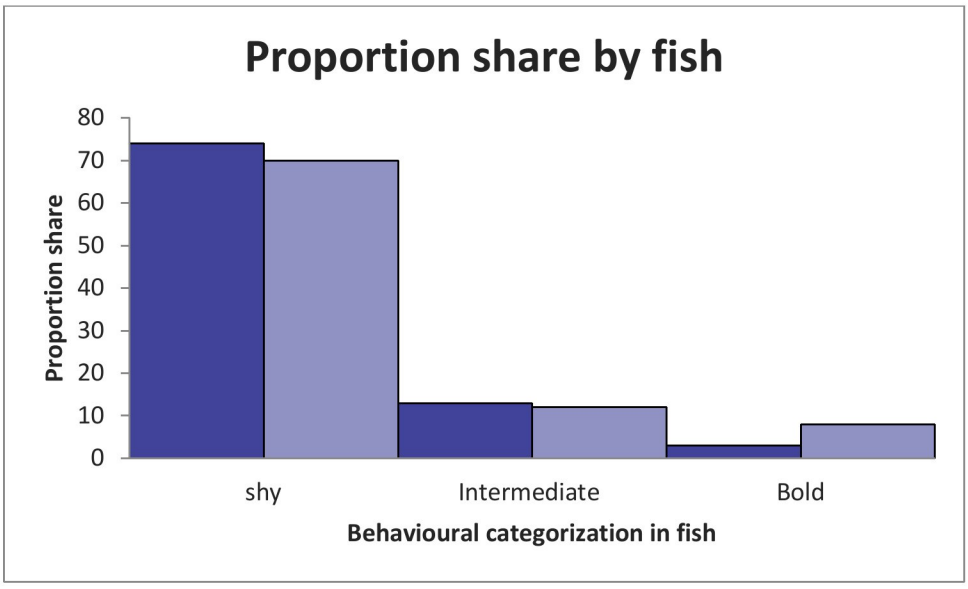

Figure 3-1 Comparative analysis of first and second experiment (Share proportion with loss of 10 individuals)

3.1 Behavioural consistency across two different novel objects

After completion of the first series of experiments with the transparent glass jar, the second series of experiment was a repeat with the same individuals from the first experiments, but with a glass jar filled with stones as the novel object from their respective tanks. The number of bold increased from three in the first experiment to eight in the second experiment (Fig.3-1). The number of intermediate fish was found to be more or less constant, i.e. 13 in the first experiment and 12 in the second one, whereas the number of shy individuals consequently was slightly lower with the 70 in the second experiment (Fig.3-1).

Again, were clear differences in types of personality Pearson chi-square test, of association χ^2=2.4238,p=0.2976 (Fig.3-1).

Pearson chi-square test of homogeneity, χ^2=47.4272, p-value=5.027e-11(Fig.3-1) in the first experiment and Pearson chi-square test, of homogeneity χ^2=36.4511, p-value=1.215e-08 in the second experiment (Fig.3-1), indicates that there is no homogeneity and all the classes are not equal. The total number of fish in the second experiment was reduced from 100 to 90, due to the unexpected loss of experimental fish mentioned above.

On a more qualitative and anecdotal basis, the experimental fish showed variable behaviours. Several fish, 20 of them were apparently somewhat afraid and did not try to explore new environment and objects. 20 fish were more cautious, and bold fish were swimming up and down and moving around more. In contrast, few of them were sitting in the same position for prolonged period of time.

3.2 Time factor

The latency period, i.e. the time each individual used before leaving the acclimation area, varied considerably among the fish (Fig.3-2,3-3) with as mean ± SD(min-max) as 428.74s ± 222.49(15-1200s). Although most of the fish, 60 % had a latency of 500 - 600 seconds, some of them even took much longer time to start exploring compared to others. Only a very few fish were found to be immediately active (Fig.3-2, 3-3).

The changes observed in the latency periods between the first and second experiment, with a gap of certain interval of time did not show much change in the individuals.

The first experimental series mean latency period of 413.54s ± 222.5(15-1200s) (Fig. 3-2), is not much different from the second with mean of 445.64s ±249.50 (30-1200s) (Fig.3-3).

To find out if there is a significant difference in the latency period data, Two sample t-test was done, t = 1.3116, p-value = 0.193, which shows that there is no significant difference in means of the latency periods from the first and second experimental data.

Some of the fish were able to reach the novel object after longer time than the time limits specified for bold and the intermediate individuals i.e. 31 fish approached after 300 seconds. A substantial number i.e. 123 fish did not approach the novel object at all were categorized as shy.

3.3 Latency period before approaching novel object

Much variation was seen among the individuals in latency period, when they tried to come out of the acclimation area to reach the novel object in the experimental area (Fig.3-4,3-5). Variation could be seen with a range of 15-1200s (Fig.3-2) in the first experiment to 30-1200s (Fig.3-3) in the second experiment. When the individuals tried to come out from the acclimation area to approach the area with novel object, the variation was seen as mean ± SD (min-max), 980.5s±392.24 (3-1200s)(Fig,3-4), in the first experiment and 947.55s±450.56(20-1200s) (fig.3-5) in the second experiment.

75 fish had latency time of 1000-1200s, 12 fish had latency of 100 -1000s and remaining three had latency of 3-60 s before approaching the novel object in the first experiment. Similarly, 69 fish had latency time of 1000-1200s, 14 fish had latency of 100-1000s and the remaining seven fish had latency of 20-50s before approaching the novel object in the second experiment.

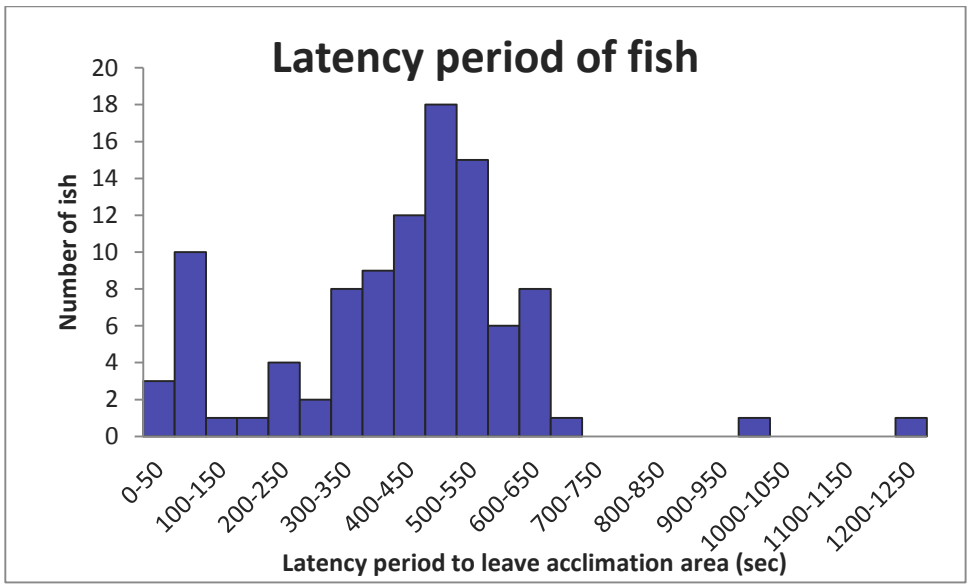

Figure 3-2 Latency period to leave the acclimation area by fish in the first experiment.

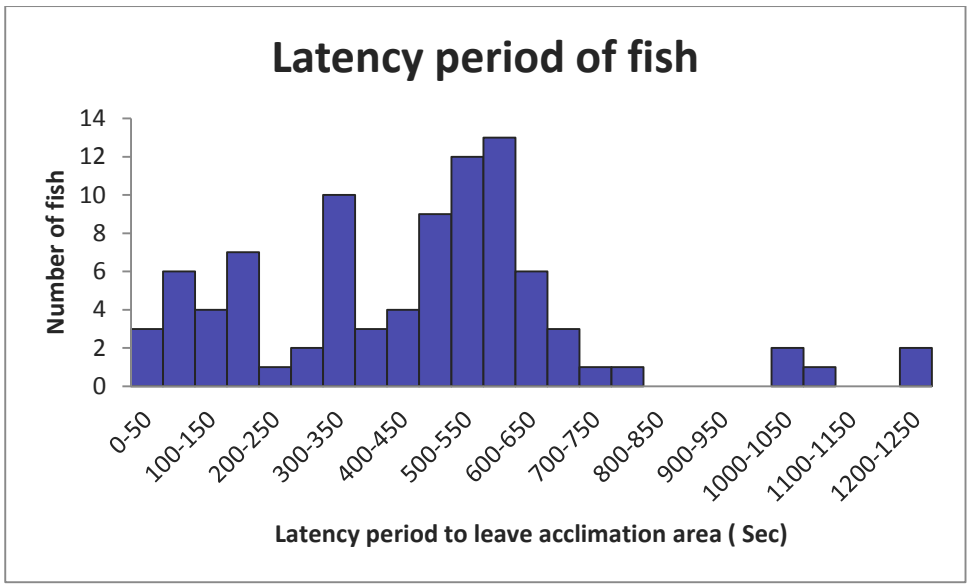

Figure 3-3 Latency period to leave the acclimation area by fish in the second experiment

3.4 Boldness

Most of the observed fish were found shy, but after the categorization when they were put in the groups with others in the tanks of the same types, they were found to be more active and social. Also, their movements were fast and they were found in groups of eight, five, three, two rather than solitary. Repeated experiment with the same individuals to check if the trout would overcome their shyness, and be bold also did not show much variation with less number of bold individuals.

3.5 Novel Object

To access the risk taking behaviour and boldness of the experimental fish, novel object test was done. Some of the fish did not even notice the novel object in the experiment. They were only moving a few distances from their original position. The mean latency period to reach novel object within 5 cm was calculated as mean ± SD (min-max) to be 964.89s± 420.07(3-1200s) in both the experiment s (Fig. 3-4, 3-5).

The mean latency to reach the novel object within 5 cm for bold individuals in the first experiment was found to be 31s ±28.5 (3-60s), with slight increase in latency to reach the novel object in the second experiment as 44.37s±32.88 (25-120s).

The mean latency to reach the novel object for intermediate individuals was found to be more in the first experiment 178.30s±41.79 (122-300s) compared to the second experiment as 160.41s±39.05 (122-120s).Similarly, the mean latency to reach the novel

object for shy individuals in the first experiment was found to be 1138.56s± 156.79 (390-1200s), which is less than the mean latency for the shy individuals in the second experiment 1185.71s ±40.35 (1000-1200s).

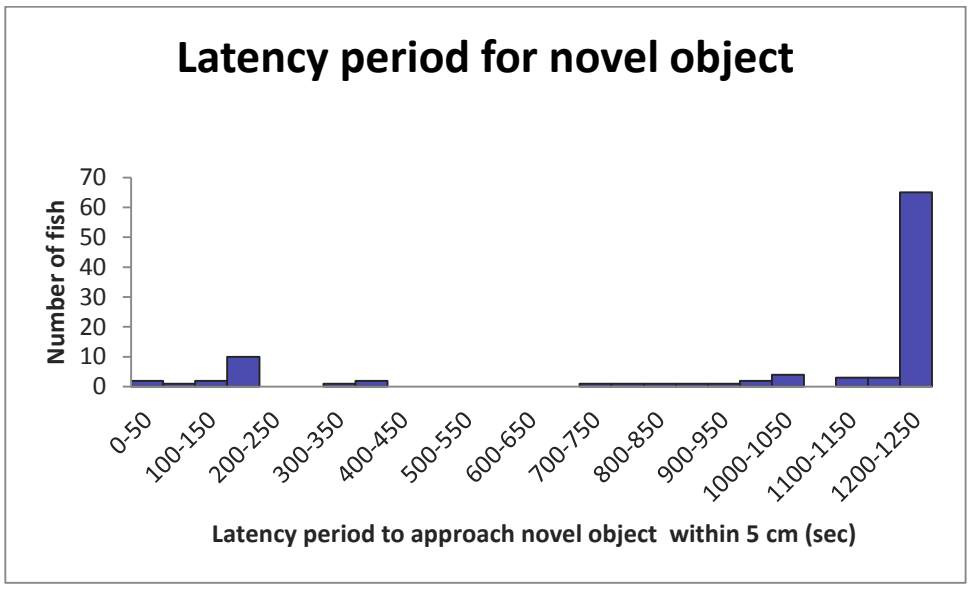

Figure 3-4 Latency period to approach the novel object by fish in the first experiment.

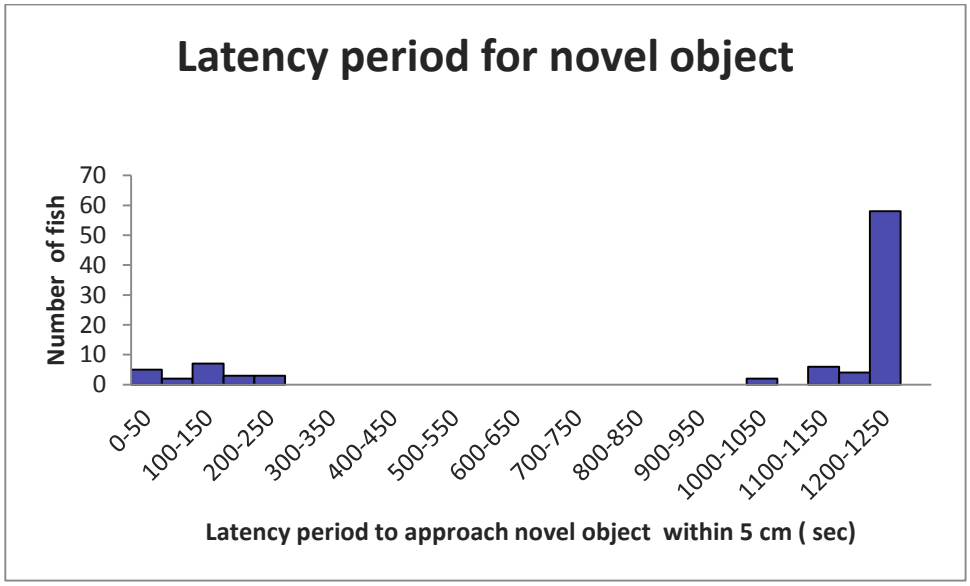

Figure3-5 Latency period to approach the novel object by fish in the second experiment.

3.6 Passive behaviour

The studied fish did not prefer exploring but often chose to be still in the same position (Fig.3-6, 3-7). Mean passive behaviour time was calculated as mean ± SD (min-max) and found to be 859.86s ±263.87 (175-1508s). But the passive behaviour was shown more

in the first experiment with mean of 887.13s ±271.03 (300-1508s) compared to the second one with mean passive behaviour of 829.56s ± 253.74(175-1200s). The fish showed hesitation to explore, continued to be in a same position with just few body movements. They did not move longer distances and covered only few squares. The latency time 1200s means the end of the experiment in this study. Only 11 individuals were found to be very active in this study.

In this experiment, 65 of them were found swimming just up and down and moving their fins to some extent. They were trying to be near the ply wood showing that they wanted a place to hide. The experimental fish were hesitating to explore when the door was opened. It looked like something was blocking them to open up in the new environment.

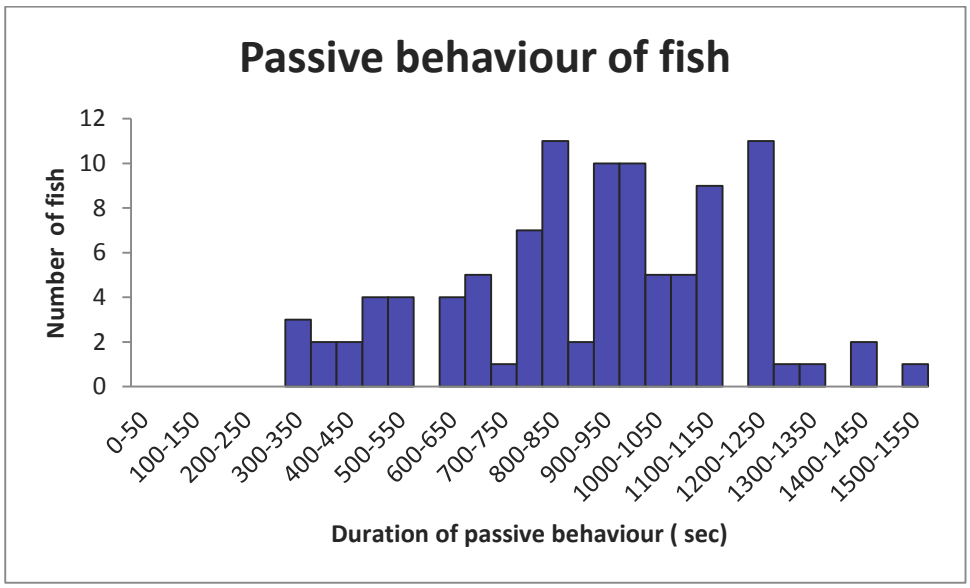

Figure 3-6 Duration of passive behavior shown by fish in the first experiment

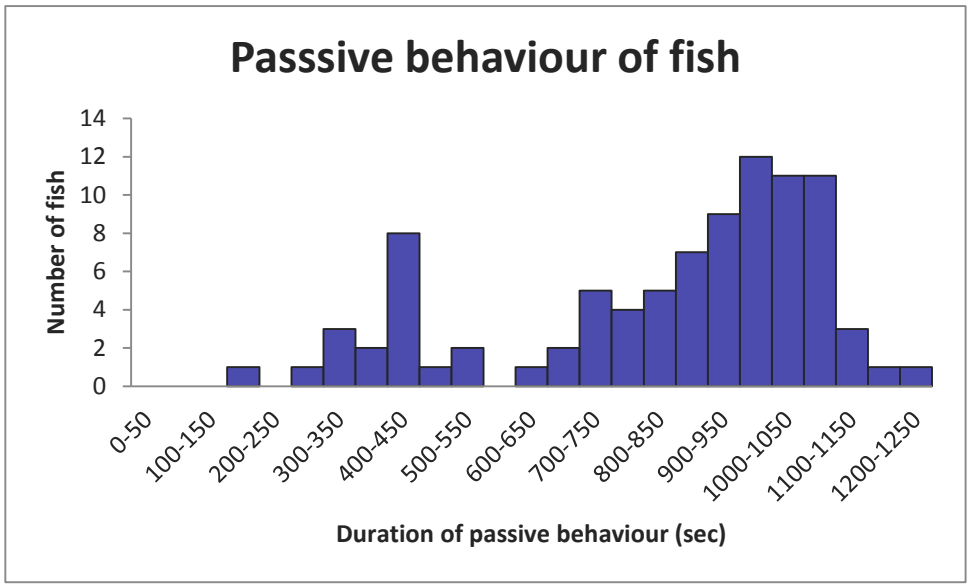

Figure 3-7 Duration of passive behavior shown by fish in the second experiment

3.7 Distance travelled

The movements of the fish were observed and total distance covered was noted in terms of the number of 64(5*5) cm squares moved (Fig. 3-8,3-9,3-10,3-11). Some of the fish moved within the same square while changing their position. The overall distance travelled by the fish was calculated as mean ± SD (min-max) and found to be 61.45cm±16 (17-135cm).The distance travelled by the fish in the first experiment was found to be less with mean of 59.87cm±19.31(17-135cm), compared to the distance travelled by the fish in the second experiment with mean of 63.22cm±11.07(40-100cm). Most of the fish were found to have covered more distance of 80-120 cm (Fig. 3-8) in the first experiment, compared to 60-80 cm (Fig. 3-9), in the second experiment.

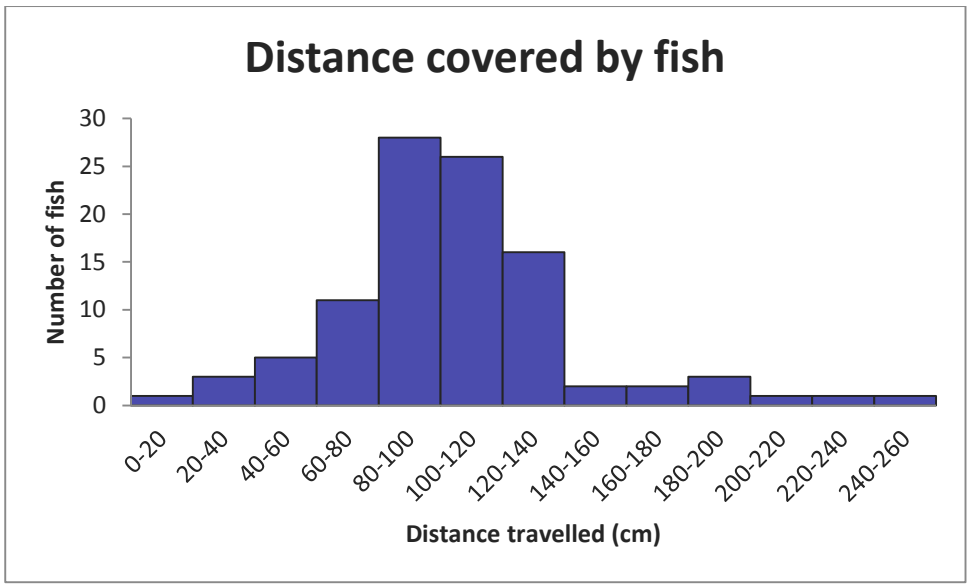

Figure 3-8 Total distance travelled by the fish in the first experiment

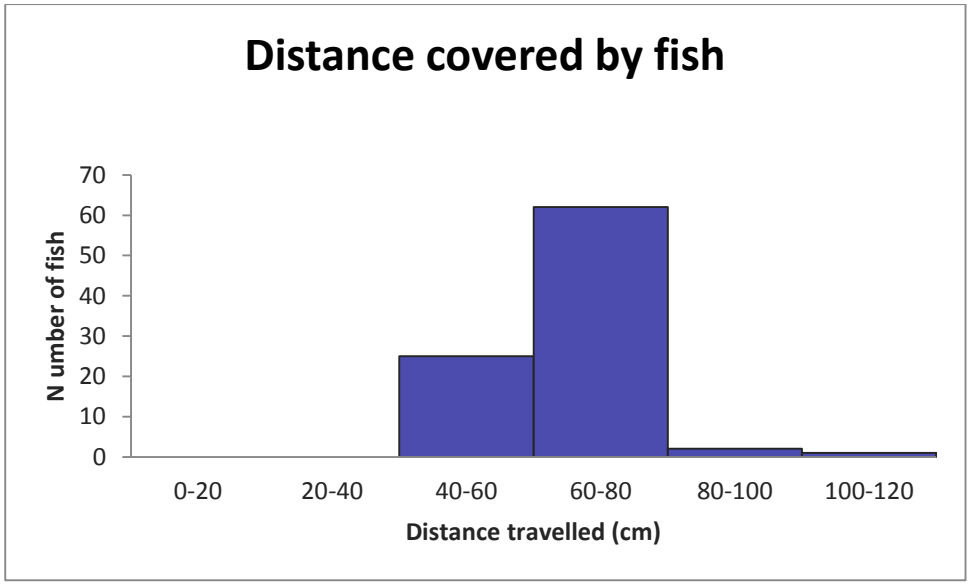

Figure 3-9 Total distance travelled by the fish in the second experiment

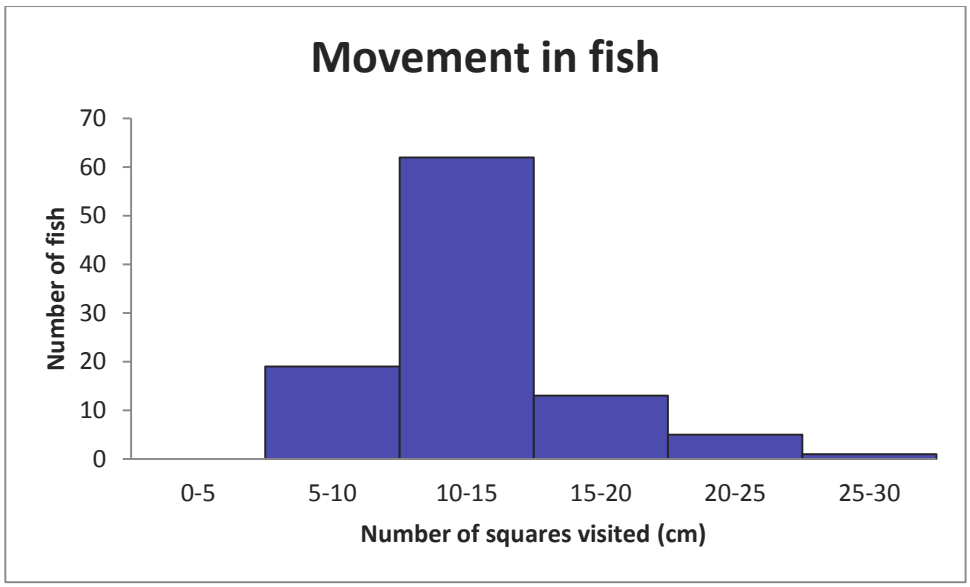

Figure 3-10 Total numbers of squares visited by the fish in the first experiment

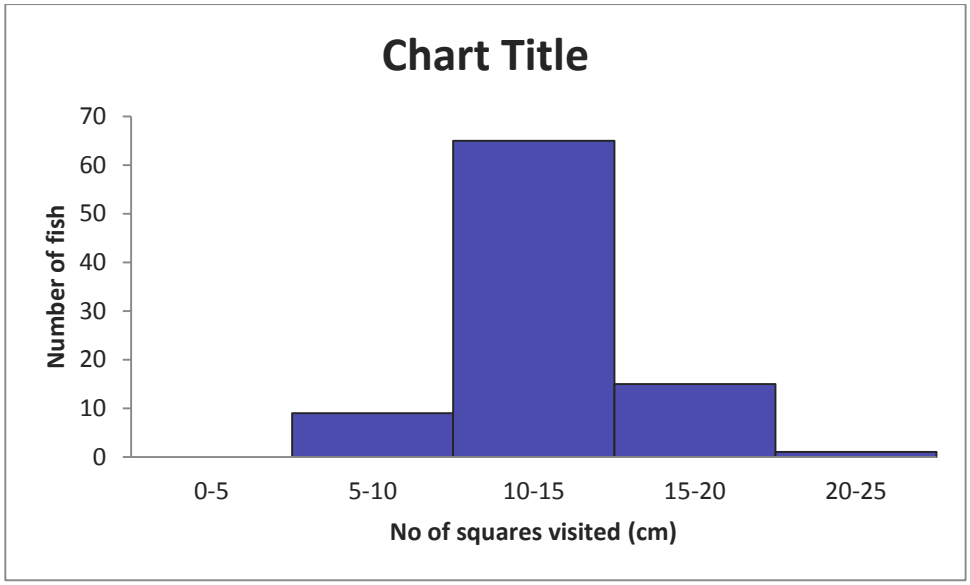

Figure 3-11 Total numbers of squares visited by the fish in the second experiment

4 Discussion

The result of the study on 100 brown trout from the Bø fish hatchery by random selection revealed high number of shy compared to few intermediate and least number of bold. Since the number of bold trout increased from first to second experiment, it might be due to turning adaptively and switching their responses from shy to bold (Sih et al., 2004, Koolhaas et al., 1999).

The study done on newly hatched brown trout found out that hatchery selection promotes boldness conveying that the fish of sea- ranched origin were bolder than wild (Sundström et al., 2004). Unlike this study, my study found higher number of shy individuals with only few bold. The boldness might also be related to the risk of predation (Magnhagen and Borcherding, 2008). According to Brown and Braithwaite (2004), the younger ones are more risk taking, but it also depends on the condition like if there is risk of predation. But, no such predation risk factor in my study could be the reason for the high number of shy individuals.

The reason why this experiment showed high number of shy fish with minimum risk taking and explorative characteristics could be a point to discuss. This could be due to no any striking colour of the novel object; the novel object used was just the natural stones put in the round glass. So, possibly the fish would not have taken much interest in exploring the novel object. The net caught many fish, out of which one was chosen for the study. Some active fish already jumped out of the net, and the one remaining in the net was used for the study. It is just an assumption, but could be the reason to high number of shy trout found in the study.

Behaviour differs at individual level and the domesticated fish is much bolder than the wild derived fish from the same stock (Huntingford and Adams, 2005), but in contrast, my results found out shy individuals in high numbers compared to intermediate and bold ones. The overall personality of the fish could be addressed as shy with not much variation. Difference in personality is essential (Wolf and Weissing, 2012) for plasticity and other life history traits.

Comparatively, not much difference was seen in the first and the second experiment done with the same species, provided the same environmental conditions and both the experiments were conducted in the same month. It looked like from the observation that the brown trout studied were not trying to explore themselves freely, with

minimum tendency to be adapted in the new environment. Few shy fish in my study was found bold in the later experiment may indicate competitive ability (Huntingford et al., 2010). However, some behaviour changes could also be context specific as explained by (Johnson and Sih, 2007).

The shy fish when transferred to their respective tanks were found to be very active and preferred to be in groups, which could be the mechanism for adaptation. Also minimum aggressive behaviour in fish can be considered as reactive coping style (Koolhaas et al., 1999, Koolhaas et al., 2007).

Most individuals were not active except few bold and intermediate. The movements in the fish were found low. They only covered few distances.The behavioural responses in shy and the intermediate individuals were almost similar except for the bold fish which were found to have plasticity in response to novelty (Thomson et al., 2012).

Most of the individuals did not possess risk taking behaviour and were found to be just sitting near the ply wood barrier, and trying to be hideous the same way as (Gatz Jr et al., 1987) point out that the brown trout's prefer to hide. As found by Adriaenssens and Johnsson (2011) that the hatchery reared brown trout are fast learners, my study found totally opposite. It could be that they were not able to be adjusted in the prevailing new environment.

Depending on the different environmental conditions, bold fish used more surviving strategies whereas the shy fish were not able to be flexible in the prevailing environment (Thomson et al., 2012). Their finding agrees to my study, where the bold individuals were exploring themselves and were cautious, and the shy individuals still continued to be shy.

Bolder animals are more explorative and risk taking, however, the explanation to these is not enough as reported in Toms et al. (2010). They argue that it is difficult to determine if a particular behaviour of interest is reflected to show the situational response. A similar case in my study with an introduction to novel object, the experimental fish did not show change in behaviour, neither was curious but Schjolden et al. (2005) argue that if they are exposed to new unfamiliar new environment, they might show different behavioural responses and perhaps new personality could be explored.

Boldness and shyness is a highlighting factor in ecological processes. The boldness may influence fitness attributes like competence, feeding, and mating behaviour (Toms et al., 2010). Behavioural differences also characterize personalities which matters for the ecological processes (Wolf and Weissing, 2012). These could be equally important for the plasticity and adaptation in the fish. As my study was done only on a general level, due to which, my study was not able to explain the individual behaviour in depth.

One important thing to be noted is that despite all the efforts for the better experimental data, there were some limitations. The black plastic curtains used in the experiment were somehow creating sound during the observation of the fish. It could also be that the fish felt my presence, or in other way there was disturbance to the experimental fish that could also be a reason for the large number of shy individuals found in the study.

5 Conclusion and recommendations

The study on 100 brown trout individuals showed similar pattern of result with shy being the highest in number followed by less intermediate and few bold fish. The exploring and risk taking tendency was found to be low. Most of them showed passive behaviour. The most common features observed in the experimental fish were moving its fins, swimming up and down. The individuals were found not being able to adapt themselves in the new environment within the given short span of time. This was observed when they were transferred from their respective tank to the experimental tank. Hesitancy to approach the novel object was seen in most of the individuals. The overall personality of the experimental fish could be addressed as shy, as the experiment found out almost 80 % of the individuals as shy.

The result obtained with the highest number of shy individuals from this study could be proceed with further research as the study was done only at general level.

The study can be proceeding further with same experimental design or with new settings or technology for the broad spectrum. The camera trapping techniques could be used further in the experiment to observe the movements of the fish in detail.

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List of tables and charts

List of Tables

Table 1 calculation done in the first experimental data 34

Table 2 calculation done in the second experimental data 36

List of figures

Figure 2-1Experimental unit design (acclimation area and experimental area divided by plywood door) 14

Figure 2-2 Map showing the study area Bø fish hatchery 16

Figure 3-1 Comparative analysis of first and second experiment (Share proportion with loss of 10 individuals)..... 17

Figure 3-2 Latency period to leave the acclimation area by fish in the first experiment. 19

Figure 3-3 Latency period to leave the acclimation area by fish in the second experiment..... 20

Figure 3-4 Latency period to approach the novel object by fish in the first experiment. . 21

Figure 3-5 Latency period to approach the novel object by fish in the second experiment...... 21

Figure 3-6 Duration of passive behavior shown by fish in the first experiment..... 22

Figure 3-7 Duration of passive behavior shown by fish in the second experiment..... 23

Figure 3-8 Total distance travelled by the fish in the first experiment..... 24

Figure 3-9 Total distance travelled by the fish in the second experiment..... 24

Figure 3-10 Total numbers of squares visited by the fish in the first experiment..... 25

Figure 3-11 Total numbers of squares visited by the fish in the second experiment..... 25

Annexes

Annex 1: Experimental data of 100 brown trout in the first experiment

Table 1 calculation done in the first experimental data

S.no	Latency period to leave acclimation area (Sec)	Latency period to approach novel object within 5 cm (sec)	Duration of passive behaviour (sec)	Distance travelled (cm)	No of unique squares visited	Types
1	180	300	600	100	20	I
2	600	1200	1200	60	12	S
3	240	1200	1100	90	18	S
4	600	1200	1245	25	5	S
5	200	180	500	105	21	I
6	645	1200	1200	35	7	S
7	300	900	850	35	7	S
8	241	1200	1440	25	5	S
9	480	800	841	25	5	S
10	545	1200	1035	30	6	S
11	618	1000	1200	30	6	S
12	585	950	1400	45	9	S
13	360	750	1080	65	13	S
14	587	399	960	65	13	S
15	660	1200	780	70	14	S
16	380	741	900	40	8	S
17	304	390	908	70	14	S
18	544	1200	900	60	12	S
19	491	1200	1204	60	12	S
20	960	1185	1508	55	11	S
21	604	1001	1080	60	12	S
22	552	998	1208	65	13	S
23	482	1102	1140	50	10	S
24	542	1106	1200	50	10	S
25	330	880	1200	45	9	S
26	390	1200	1080	40	8	S
27	424	1200	1100	65	13	S
28	498	1200	1320	55	11	S
29	350	1200	900	55	11	S
30	450	1200	328	65	13	S
31	362	1200	900	55	11	S
32	260	1200	960	45	9	S
33	489	1200	918	50	10	S

34	319	1100	903	55	11	S
35	515	1150	840	50	10	S
36	440	1000	940	50	10	S
37	380	1200	841	60	12	S
38	489	1200	1140	70	14	S
39	450	1200	965	50	10	S
40	480	1200	685	50	10	S
41	30	1200	500	60	12	S
42	450	1200	1020	50	10	S
43	413	1200	1100	55	11	S
44	413	1200	901	60	12	S
45	445	1200	1025	45	9	S
46	343	1200	790	50	10	S
47	60	180	300	75	15	I
48	545	1200	1201	70	14	S
49	320	1200	849	55	11	S
50	60	129	300	75	15	I
51	365	1200	849	60	12	S
52	510	1200	1000	40	8	S
53	545	1200	990	45	9	S
54	500	1200	960	50	10	S
55	440	1200	800	50	10	S
56	483	1200	1100	45	9	S
57	543	1200	1250	50	10	S
58	200	180	420	75	15	I
59	390	1200	785	60	12	S
60	613	1200	1020	60	12	S
61	543	1200	1140	55	11	S
62	75	180	450	85	17	I
63	425	1200	960	65	13	S
64	575	1200	1100	65	13	S
65	300	1200	960	75	15	S
66	543	1200	885	50	10	S
67	70	182	500	75	15	I
68	380	1200	1080	70	14	S
69	95	3	400	110	22	B
70	80	180	480	100	20	I
71	483	1200	660	50	10	S
72	80	181	500	90	18	I
73	81	179	600	120	24	I
74	600	1200	800	60	12	S
75	480	1200	720	65	13	S
76	600	1200	960	55	11	S
77	90	160	841	70	14	I
78	20	30	350	135	27	B

79	580	1200	1100	55	11	S
80	483	1200	960	60	12	S
81	80	122	480	75	15	I
82	512	1200	785	75	15	S
83	482	1200	841	65	13	S
84	485	1200	1245	60	12	S
85	542	1200	1081	70	14	S
86	543	1200	840	50	10	S
87	401	1200	842	40	8	S
88	445	1200	961	65	13	S
89	15	60	360	80	16	B
90	120	165	470	17	15	I
91	511	1200	900	60	12	S
92	454	1200	785	45	9	S
93	420	1187	600	55	11	S
94	333	1200	616	35	7	S
95	280	1200	664	65	13	S
96	1200	1200	1245	50	10	S
97	449	1000	789	70	14	S
98	498	1200	660	75	15	S
99	585	1200	664	65	13	S
100	422	1200	780	55	11	S

Annex 2: Experimental data of 90 brown trout in the second experiment

Table 2 calculation done in the second experimental data

S.no	Latency period to leave acclimation area (Sec)	Latency period to approach novel object within 5 cm (sec)	Duration of passive behaviour (sec)	Distance travelled (cm)	No of unique squares visited	Types	Repeated experiment
1	30	25	419	85	17	B	B
2	50	30	415	75	15	B	B
3	120	122	480	75	15	B	I
4	160	122	400	45	9	I	I
5	165	122	500	65	13	I	I
6	80	120	415	65	13	I	B
7	195	200	440	70	14	I	I
8	172	129	421	60	12	I	I
9	146	128	397	65	13	I	I
10	204	205	311	75	15	I	I
11	90	40	300	100	20	I	B

12	80	50	250	75	15	I	B
13	190	185	311	60	12	I	I
14	45	189	400	60	12	I	I
15	484	1100	980	50	10	I	S
16	120	123	500	65	13	I	I
17	482	1200	1080	60	12	S	S
18	348	1200	1100	45	9	S	S
19	580	1100	695	45	9	S	S
20	525	1000	840	55	11	S	S
21	560	1200	720	70	14	S	S
22	345	1200	600	65	13	S	S
23	790	1200	1000	45	9	S	S
24	580	1200	695	50	10	S	S
25	1200	1158	998	70	14	S	S
26	604	1200	918	50	10	S	S
27	548	1200	900	65	13	S	S
28	498	1167	1080	60	12	S	S
29	330	1200	901	60	12	S	S
30	613	1200	845	65	13	S	S
31	680	1148	1085	50	10	S	S
32	180	1200	918	75	15	S	S
33	515	1200	780	65	13	S	S
34	514	1001	870	70	14	S	S
35	645	1200	960	70	14	S	S
36	520	1200	980	75	15	S	S
37	50	20	389	75	15	S	B
38	40	50	400	95	19	S	B
39	600	1145	1079	65	13	S	S
40	380	1200	900	70	14	S	S
41	480	1200	890	70	14	S	S
42	590	1200	780	55	11	S	S
43	110	180	700	75	15	S	I
44	519	1200	840	60	12	S	S
45	580	1200	899	75	15	S	S
46	545	1200	1100	70	14	S	S
47	613	1200	845	75	15	S	S
48	514	1200	965	50	10	S	S
49	348	1200	1000	70	14	S	S
50	415	1200	789	65	13	S	S
51	720	1200	720	50	10	S	S
52	540	1200	999	60	12	S	S
53	680	1200	1011	70	14	S	S
54	335	1200	900	50	10	S	S
55	312	1200	1020	75	15	S	S
56	518	1200	989	45	9	S	S
57	381	1200	971	40	8	S	S

58	589	1200	1080	50	10	S	S
59	350	1200	1051	55	11	S	S
60	448	1200	880	60	12	S	S
61	1000	1200	859	70	14	S	S
62	335	1200	1075	75	15	S	S
63	1200	1100	1185	70	14	S	S
64	480	1200	914	55	11	S	S
65	1001	1200	889	60	12	S	S
66	591	1200	1040	60	12	S	S
67	280	1200	1100	55	11	S	S
68	495	1200	998	55	11	S	S
69	511	1170	1002	45	9	S	S
70	580	1200	1075	70	14	S	S
71	501	1200	899	70	14	S	S
72	460	1200	799	65	13	S	S
73	667	1113	998	45	9	S	S
74	645	1200	1042	65	13	S	S
75	451	1200	1005	70	14	S	S
76	330	1198	1070	55	11	S	S
77	290	1200	1050	70	14	S	S
78	498	1200	1011	75	15	S	S
79	68	20	945	60	12	S	B
80	570	1200	1087	65	13	S	S
81	400	1200	742	45	9	S	S
82	330	1200	1004	65	13	S	S
83	580	1200	900	65	13	S	S
84	189	220	175	60	12	S	I
85	1080	1200	1200	65	13	S	S
86	580	1200	1014	60	12	S	S
87	590	1200	984	60	12	S	S
88	430	1200	800	70	14	S	S
89	598	1200	978	50	10	S	S
90	333	1200	720	70	14	S	S